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Erratum: In JPRS-CST-93-014, 17 Aug 93, p 12, second column, second paragraph, line 7 should read: "Changkong"; line 23 should read: first long-range carrier rockets.

SCIENCE & TECHNOLOGY POLICY

AEROSPACE

ADVANCED MATERIALS

BIOTECHNOLOGY

COMPUTERS

FACTORY AUTOMATION, ROBOTICS

LASERS, SENSORS, OPTICS

MICROELECTRONICS

SUPERCONDUCTIVITY

TELECOMMUNICATIONS R&D

PHYSICS

Taiwan-Russian S&T Cooperative Projects Described

93FE0775A Taipei K'OHSUEH FACHAN YUEK'AN [NATIONAL SCIENCE COUNCIL MONTHLY] in Chinese Vol 21 No 2, Feb 93 pp 95-100

[Article by Shih Hung-Chih [2457 7703 1807], Ch'en Wen-Chun [7115 2429 0193], and Wang Ch'eng-i [3769 6134 0001] of NSC's International Cooperation Office: "Taiwan-Russian S&T Cooperative Development Strategy"]

[Text]

I. Introduction

The Taiwan-Russian relation had been frozen for 40 years. With the disintegration of the Soviet Union and Taiwan's increasingly strong political and economic power, Taiwan and Russia now have the opportunity to make some contacts and cooperation in S&T, trade and culture areas. In today's international climate, it is nothing short of a positive diplomatic breakthrough to change an enemy into a friend, to gradually understand each other, and to establish S&T cooperation. It is something worth pursuing by both sides with frankness and sincerity.

Russia is endowed with a large territory and rich natural resources. It has a superior rank of science and technology workers and strong heavy industry, defense industry and aerospace industry. It has also played a major role in the area of literature, music, arts, architecture and athletics. Since the disintegration of the former Soviet Union, however, there has been an outflow of talent, a shortage of foreign exchange, a dire shortage of consumer goods, and severe inflation. In Taiwan, on the other hand, we have a superb consumer goods industry and a robust economy, the largest foreign exchange reserve in the world, and a trained workforce. Taiwan is undergoing an economic transition and trying to break through a number of technological bottlenecks. If Taiwan and Russia can cooperate by introducing Russian technology and technical workers to Taiwan and by exporting Taiwanese consumer goods and light industry to Russia, the cooperation should be complementary and beneficial to both sides.

Three years ago in 1990, the State Science and Technology Commission of the former Soviet Union contacted our Science and Technology Section stationed in Germany and invited the section director, Meng Hsien-Yu [1322 2009 6877], to visit a number of important Russian institutes in May 1991. We subsequently invited Dr. Antonovsky, member of the Academy of Sciences of the former Soviet Union, and Dr. Alshin, director of the National Physical Technology and Radio Measurement Technology Institute, to visit Taiwan in May of the same year. In addition to giving seminars during their visit, they also held discussions with Taiwan manufacturers and described the technology transfer policy in Russia. After this interaction, Dr. Hsu Chang [1776 4545], director of the Measurement Center in the Industrial Technology Research Institute (ITRI) and director of the National Standards Laboratory, and Associate Section Director Dr. Han Posheng [7281 0590 3932] were also invited to visit the Russian institute and signed a cooperation memorandum for collaboration on metrology. The memorandum was also endorsed by the Telecommunications Research Institute of the Ministry of Communications and the Institute of Nuclear Energy Research under the Atomic Energy Council. In June of the same year, the Russian oceanographic research vessel Vinogradov visited Taiwan and in July and September Section Director Meng revisited Russia to discuss Taiwan-Russian technology cooperation and was well received. On 1-11 November 1991, a four-member Russian delegation led by Dr. Boris I. Kryukov, deputy director of Russia's International Engineering Academy, visited Taiwan and signed the first official Memorandum for Science and Technology Cooperation between the two governments with Deputy Director Wang Sungmao [3769 2646 5399] of the National Science Council (NSC) in Taiwan.

It was pointed out in the Memorandum that representatives of both sides agreed to notify their counterparts about forthcoming academic meetings and other S&T activities, to provide visitors with the necessary assistance, and to support the exchange of engineers, scientists, and expert scholars. Based on cooperative projects, the principal scope of cooperation would be mutually agreed upon. To ensure exchange, the two sides would meet every other year.

In order to strengthen the Taiwan-Russian cooperation and to have a first-hand understanding of the situation in Russia, the NSC sent a six-member delegation, led by NSC Director Mr. Hsia [Han-Min], to visit Russia on 7-14 December 1991. The delegation interacted extensively with the Russian Ministry of Science and Technology Policy (MSTP), S&T transfer company (s), the Institute of Aerospace Materials, Moscow University, a scientific satellite research organization, the Russian Academy of Engineering Sciences, and space station design and production units. The NSC delegation also held high-level negotiations with MSTP Minister B. G. Saltykov and International Engineering Academy President Prof. Boris V. Gusev on the basic content of future bilateral S&T relations, culminating in the signing of a bilateral agreement on S&T cooperation that served as the basis for future specific cooperation.

From 20-28 December 1991, a three-person delegation led by Russian Academy of Sciences (RAS) Institute of Physics Associate Director Dr. V. V. Osiko visited Taiwan and held a seminar at Chiao Tung University, with speeches from Dr. Osiko and Dr. I. A. Scherbakov. The delegation also visited National Tsing Hua University, National Central University, National Taiwan University Medical School, ITRI, the Synchrotron Radiation Center, and the [Hsinchu] Science Industry Park, and held discussions with Prof. Li Yuen-Che [2621 6678 0772] about S&T cooperation and personnel training. The Osiko group also held a press conference at NSC and interacted with Chinese scholars in relevant fields. The main topics of discussion were: basic and applied

research in Russia and Taiwan, the desire of both sides to exchange scientists and participate in the other side's technical meetings, and arrangements for a Taiwan delegation to visit Russia and for the optoelectronics exposition in Taipei at the end of 1992. This visit was very beneficial to the establishment of Taiwan-Russian S&T cooperation.

At the invitation of the NSC, MSTP Chief Advisor Dr. [Vladimir V.] Ezhkov led a five-person delegation to Taiwan on 13-21 March 1992 and signed a Taiwan-Russian Science and Technology Cooperation Agreement between MSTP and NSC on the morning of 18 March 1992. The content of the agreement consists of the establishment of S&T representative units, a technology transfer fund, and five specific projects for cooperation: 1) introduction of a high-efficiency, low-pollution engine, 2) introduction of a high-energy battery, 3) development of electronic materials and high/low-temperature superconductors, 4) development of lasers for medical applications, and 5) R&D of optoelectronics. After the signing of the agreement, NSC invited scholars and experts in the relevant fields to hold extensive discussions with the five-person Russian delegation.

Instructed by Director Hsia, the International Cooperation Office of NSC promoted bilateral S&T ties and selected six specific cooperative projects in May 1992: 1) high-energy physics, 2) nonlinear optics, 3) high/low-temperature superconductivity research, 4) high-performance composites, 5) high-power laser technology, and 6) development of high-energy batteries and satellite components. After 3 months of planning and with coordination by the Science and Technology Section stationed in Germany and direct contact by Visiting Professor Yang Ch'i [2799 2790], the projects were effectively implemented according to the S&T cooperation agreement signed in December 1991 by NSC and the Russian Academy of Engineering Sciences. As called for in the agreement and at Taiwan's request, the Russian Academy of Engineering Sciences actively arranged visits by NSC officials. In late September 1992, a nine-person delegation of NSC officials, university professors, and industry leaders traveled to Russia for a 10-day inspection tour of cooperative project sites. The nine members were Director Shih Hung-Chih of NSC's International Cooperation Office, Professors Wu Mao-K'un [0702 5403 2492], Wan Ch'i-Ch'ao [8001 0366 6389] and Ma Chen-Chi [7456 2182 1015] from National Tsing Hua University, Professor Liu Hai-Pei [0491 3189 0554] of National Central University, Professor Yang Ch'i from Tamkang University, Section Chief Chao P'eng [6392 7720] of the National Space Planning Office (NSPO), Lian Hua Electronics Co. Manager Ch'en K'un-Lu [7115 3540 6922] of the Hsinchu Science and Industry Park Bureau, and Market Director Wei Shi-Chin [7614 1102 2516] of Taiyang S&T Company. The organizations they visited in Russia included the Obon-insk (?) S&T Production Company, the Monika (?) S&T Production Company, the RAS's General Physics Institute (GPI) and Institute of Solid State Physics (ISSP), the Shatura Industrial Lasers R&D Center, MSTP, the Russian Space Agency's Scientific Research Institute of Thermal Processes (NIITP), the Ministry of Aviation Industry's Aviation Materials Joint Research Center, Moscow University and its Institute of Engineering Physics, and the Moscow Aviation Institute.

We now describe each of the Taiwan-Russian cooperative projects.

(I) R&D of Russian Superconductors and Their Application

The development of superconductivity technology has a long history in Russia and has gained maturity. In addition to results in basic research, the application of low-temperature superconductivity is relatively mature in Russia, particularly the application of low-temperature superconducting wires in magnets for nuclear fusion reaction research and in high-energy accelerators. In the space below we describe the findings of the visit:

1. Portions With Potential for Immediate Technical Introduction

(1) Technologies directly related to superconductivity.

(i) Manufacturing of superconducting wires and cryogenic systems, leading to small superconducting magnets. In addition to satisfying the Taiwan market, there are considerable demands in Southeast Asia. This can further lead to medium and small magnetic-energy storage for microelectronics industry applications. (This technology resides in the RAS's Institute of Atomic Energy [IAE].)

(ii) Manufacturing technology for microminiature high-sensitivity sensors such as superconducting quantum interference devices [SQUIDs] and systems for medical and geological exploration (e.g., seismologic) applications. (This technology is available at Moscow University.)

(2) Technologies related to research on superconducting materials.

(i) Special ceramic crucibles (boron nitride material) for fabricating high-temperature superconducting materials.

(ii) Bonding agents for ceramic materials that maintain high strength at elevated temperature. High-temperature superconducting composite materials with high mechanical strength. (These two technologies provided by Technologia Company.)

(iii) Measurement devices (such as miniature resistive thermometers, magnetic field measuring devices) needed in superconductivity research (e.g., semiconducting, metallic and magnetic characteristics). (ISSP)

(iv) Laser lithography superconducting element technology. Direct scan lithography of element circuits using focused laser beams. (Moscow University)

2. Mid- to Long-Term Technology With Potential

(1) Etching of ASICs with laser holographic technology and application of laser 3-D photography. Manufacturing of special complicated devices with one-step projection. (Moscow University)

(2) Development of nonmetallic low-temperature coolant (liquid nitrogen or liquid helium) containers. (Moscow University)

(3) Metal-ceramic superconducting composites, directional crystallographic growth technology, and development of continuous high-performance superconducting wires. (ISSP)

3. Frontier Technology That Provides Cooperative Projects in Basic Academic Research

(1) Complete neutron diffraction facility for providing detailed crystalline structure of materials and phonon spectrum and magnetic structure analysis from 4 to 500K. (IAE)

(2) Study of two-dimensional electron systems by magneto-optic techniques. (ISSP)

(3) Research on application of scanning tunneling microscope (STM) energy spectrum technology for studying superconducting flux pinning phenomena. (ISSP)

(4) Research on photo-induced superconductivity and phenomena of changing carrier density. (RAS's Institute of Physical Problems)

(5) Study of helium crystal growth and physical properties at ultra-low temperatures achieved by dilution refrigerator. (IAE)

With regard to research personnel exchange, all the institutes visited by the Taiwan delegation enthusiastically welcomed interested Chinese scientists for short-term or long-term visits. Similarly, many outstanding senior researchers are willing to visit and work in Taiwan for 1-2 years.

(II) High-Power Laser Technology in Russia

Lasers, including CO_2 lasers, color-center lasers, and conjugate cavity garnet lasers, are extreme high-tech products worthy of introduction. However, different approaches should be used for the Shatura Industrial Lasers R&D Center and GPI because the former is an engineering and production center whereas the latter is a research institute. The approaches are described below.

1. The initial intention of the Shatura Industrial Lasers R&D Center was to invite Taiwan companies and research organizations to rent their existing space. The center is located in Shatura, 120 kilometers from Moscow, and has a large ground and many nice buildings. It intends to become a high-tech zone similar to a research park. However, due to lack of money, a large number of the buildings are idle, hence the desire to rent them out to outsiders. Director Shih Hung-Chih suggested that the center may cooperate with Taiwan by producing lasers in Taiwan, which Shatura Center Director Professor Panchenko considered feasible. The advantage in cooperating with this center is that it already has developed lasers and peripheral systems, only that their appearance is crude and the output of each model is only two or three units a year. Prof. Panchenko agreed that, with the technology of his center and Taiwan's efficiency and quality, good products can be produced.

2. The immediate action is to identify interested Taiwan companies. These companies should include machining and optical instrument makers in order to facilitate production and sales. After the companies are recruited, negotiations should begin to determine the organization of the new company and the investment amount. In the initial phase of the company, a technology transfer unit should be formed at National Central University so that some experienced engineers and professors may cooperate with the Russian side to produce the prototypes. Since the Russian Shatura Center has already completed the prototypes, Taiwan only needs to beautify their exterior appearance and make partial modifications according to the parts-supply situation and application environment in Asia. For formal production, a plant should be built in the Hsinchu Science and Industry Park to take advantage of various support and benefits. The sales aspects should be handled by the machining and optical instrument makers.

3. The reason for the extremely low output of the Shatura Center is because there are too many models. Taiwan proposes to import the multi-tube waveguide laser first. This is because the output of this type of laser can already satisfy the needs of the various laser manufacturing centers and most of the parts can be made in Taiwan. The Russians have described the working principles of the laser without reservation and the technology and know-how of Taiwan are sufficient to pick up this technology. As to large-scale lasers that use turbofans, they may be introduced when there is a market need.

Lasers of the GPI are still in the experimental stage. Although they possess commercial value, the new company will not be able to produce them. However, since these lasers are highly valuable for academic research, academic organizations in Taiwan may import these experimental setups.

(III) Satellite Components Development Technology

1. Satellite Department of the Moscow Aviation Institute (MAI)

MAI was established in 1930 and belongs to MSTP. It now has 20,000 students, 2,000 professors and 4,000 researchers. It has nine academic departments: applied mathematics, aircraft, helicopters, rockets, control systems, radio, space, subsystems, and economic management. In addition to the teaching function, MAI's mission also includes aerospace research and university-industry cooperation. There are 20 American graduate students from MIT studying at MAI today. MAI is authorized by the Russian government to enter into contracts with foreign organizations and no other approvals are needed.

The Satellite Department is a combination of professors and researchers from all the relevant departments. It designs, develops and produces research and communications satellites that weigh 50 to 400 kg and have an orbit altitude of 400 to 700 km. The payload missions are the monitoring of space environment, space station, communications, earth atmosphere and gravity research. The launch vehicle for these satellites is mainly the Soyuz rocket. What distinguishes MAI from other aerospace institutes in Europe is its emphasis on the teaching of design and on hands-on experience. The professors lead the students through the definition of satellite mission, system and subsystem design, components, calculation, drafting, model fabrication, and testing. The teaching is entirely in the mode of systems engineering.

Prof. Plotnikov expressed that he would be happy to discuss technology transfer with Taiwan without any reservation:

(1) Invite and receive visitors from Taiwan, tour laboratories.

(2) If invited, he can send four experts to Taiwan for lecture and answering questions.

(3) Possible topics for cooperation may include all systems of the satellite or only the subsystems and components. MAI may provide design specifications, material and process selection, testing methods and facilities, mathematical modeling, and software development.

2. The Scientific Research Institute of Thermal Processes (NIITP)

NIITP was established in 1930 and is one of the three major research institutes of the Russian Space Agency (the other two are the Institute for Structures, Design and Control, and the Institute for Experiment and Testing). It was a classified unit and became open in 1989. It has 300 Ph.D.s and doctoral candidates, 700 engineers and 1,000 other staff.

NIITP developed the world's first industrial rocket, the GIRD-X, in 1933 and made its name in World War II with the Katyusha rocket in 1941. The main missions of this institute are rocket propulsion, electrical systems, thermal processing, and supervising Russia's rocket industry. According to Deputy Director Golovin, the main interest of the institute is to provide launch vehicles. He understands the concern of the international community and says the difficulties can be resolved by the Russian Space Agency.

NIITP is now seeking support and international partners to develop the following projects:

1. Plasmotrons (High-Temperature Poison Gas Disintegration Ovens)

The plasmotron converts poisonous gases into nonpoisonous using 8,000K high temperature. To date, the first model has been produced but $2 million and 1 year's time are required to improve it. The main frame is estimated to cost $200,000.

2. Gasification Technology

This technology treats urban waste and tires using a super adiabatic technique. The technique controls the temperature distribution and the maximum temperature so that low-grade fuel with 10 percent combustibility may be burned to an efficiency of 90 to 95 percent.

3. Powder Metallurgy

In this technology the metal powders are sprayed with an aerodynamic technique and then heated and sintered. They are used to enhance the surface of components or turbine combustion chambers. They are also applied in laser printers and copiers.

4. Plasma Propulsion

In plasma propulsion, charged particles are used to impinge the surface of tools to modify the surface structure and thereby improve the resistance against wear and corrosion.

5. Solid Fuel Propulsion Technology

Miniature rockets are used to enable sudden braking in ships and trains.

6. Jet Cleaning

Liquid rocket technology is used to spray a jet of gas and sand mixture for removing paint or barnacles on the bottom of a ship without damaging the surface.

Our recommendations for this area are:

1. Further understanding NIITP's surface coating and surface treatment technologies; consider transferring these technologies to Taiwan for processing the surfaces of satellite hardware.

2. Import NIITP's high-thrust and low-thrust small engine technologies for satellite attitude control, 3-axis stabilization, and orbit raising/maneuvering.

3. Explore the advantages and application potential of the HEATER and HEAT PIPE technologies.

(IV) Russian Storage Battery S&T

MAI is Russia's largest aviation college and research center and covers all aviation-related industries such as communications, electronics, satellites, combustion, control, and materials. Students from famous American universities such as MIT and from Germany, Korea and China come here to learn aircraft design. The institute also does technological development for the European Ariane Space Program.

The aluminum/air battery is a room-temperature fuel cell and not a storage battery. It has an extremely long shelf life and its discharge energy density is reported to be 200 Wh/kg, which is about five times that of lead-acid batteries. The battery has good potential as an electric vehicle energy source. If oxygen is used in the aluminum/air battery, the discharge performance is even better and may reach 750 Wh/kg. However, the aluminum/oxygen battery must use the expensive platinum catalyst and is only suited for aerospace applications; it has been used

on Russian spaceships. Aluminum/air batteries may replace small NiCad batteries or alkaline batteries.

(V) Introduction to Electronic S&T Research Units in Moscow

1. Special Research Bureau of Moscow Power Engineering Institute (OKB MEI)

MEI, located in Moscow city, has satellite ground stations at a number of locations including "Big Bear Lake" in the suburbs of Moscow. It now has 1,500 researchers, engineers, and technicians engaged in the following research:

(1) Image and data conversion in satellite digital television systems.

(2) Digitization of low-orbit satellite communications systems.

(3) Application of low-orbit satellite communication systems in public education, medicine, and environmental protection.

(4) Building low-cost satellite ground stations based on the Russian "Gorizont" [Horizon] satellite, such as the small-aperture satellite ground-station system (VSAT).

(5) Remote communications systems using underwater ultrasonic systems.

This unit is specialized in ground-station research and may benefit some of the academic institutes in Taiwan that plan to build satellite ground stations. Although the theoretical basis of this institute may be good, the instruments and operational concepts used by the institute are rather crude and backward. In further contacts with this institute we should pay attention to the theoretical design of systems and not products and technologies that are ready for transfer.

2. Moscow Institute of Communications

This institute is located inside Moscow and has almost 20,000 students, 1,200 professors, researchers, and staff. It engages in research on digital communications, fiber-optic communications, automatic control, microwave communications, and so on. In addition to a visit with the institute president, special arrangements were made to visit the Solid-State Microwave Component Design and Development Laboratory.

The Solid-State Microwave Laboratory is specialized in K-band and X-band Gunn and IMPATT stabilized or synthetic oscillator power mixers and amplifiers. In the last 4 years, the institute has been devoted to R&D of power MESFETs for nonlinear MESFET components. Research results include broadband power amplifiers developed from the Russian MESFET transistor and a series of power oscillator frequency multipliers and mixers made from MESFETs.

NSC personnel found that Taiwan companies are also capable of producing these types of products with no less performance. There is therefore little value for import.

3. Pulsar Company

The Pulsar Company is the first developer and maker of semiconductors in Russia; its business has two directions:

(1) High-frequency microwave transistors and silicon transistors suitable for 1 GHz, 150 to 200 Watts, and 10 GHz, 1 to 5 Watt applications.

Gallium arsenide transistors and their application at 5 GHz (5 to 10 Watts) and at 15 GHz (1 to 2 Watts).

Pulsar makes transistors with electronic technology and can therefore produce gate lengths of 0.3 μm.

(2) Down-converters and dish antennas for satellite television.

Taiyang S&T Company in Taiwan's Hsinchu Science and Industry Park has produced this type of product with better specifications.

At the present stage, transistors produced by Pulsar may serve as an alternative source for Taiwan provided the quality and price are competitive. They may be used to address the monopolizing situation by Japan.

II. Recommendations for Taiwan-Russian S&T Cooperation

1. Frontier technologies suitable for universities and the Academia Sinica:

(1) Generation of soft X-rays with high-performance lasers in plasma to serve as X-ray light source for submicron lithography.

(2) X-ray lenses for focusing X-rays of different wavelengths. This can greatly increase the density and efficiency of X-ray beams.

2. Scientists to invite to Taiwan:

(1) Professor Pashinin of RAS's GPI and one or two young Ph.D.s (for laser-generated X-ray technology).

(2) Professor Kumakhov and one or two young Ph.D.s from the Russian Research Center (formerly the IAE) (for X-ray lens technology).

(3) Professor Lyubutin of the RAS's Institute for Crystallography for the study of solid-state electronic structures using the Mossbauer effect.

Australia, China To Increase Tech Links

Bilateral Trade To Increase

40100108A Beijing CHINA DAILY in English 8 Sep 93 p 1

[Article by staff reporter Wang Yong]

[Text] China and Australia yesterday pledged to cement cooperation in high-technology that will usher in a new era of bilateral relations.

"Australia and China have the opportunity to grow together in new and exciting areas," declared visiting Australian Trade Minister Peter Cook at the opening

ceremony of the largest economic forum between the two countries in Beijing yesterday.

The 2-day forum has attracted some 100 Australian business people from more than 80 companies covering a wide range of industries.

Cook disclosed that Australia's Suspension Components Company would sign a joint venture agreement in Shanghai in a few days to transfer technology to China for the manuafacture of stabilizer bars for the motor industry.

Alcatel will sign a contract today to export $14 million worth of system 1240 telephone exchanges to a Heilongjiang end-user.

Earlier, Alcatel had sold its products to Anhui and Qinghai provinces worth about $40 million.

Wu Yi, Chinese Minister for Foreign Trade and Economic Cooperation, predicted that bilateral trade would set new records in the years to come as both sides have started to export more high quality products to each other.

She said the two nations have good prospects of cooperation in aviation, transportation, energy, telecommunications and metallurgy sectors and so on.

She said China has yet to revamp tens of thousands of medium and small-sized ventures, a plan that could offer Australian investors good market niches.

She noted that more and more Australian smaller businesses plan investment in China's coastal areas like Shanghai and Jiangsu Province.

China's import of industrial plants and electromachinery products from Australia has seen a big increase in the past few years.

She said China's import of Australian wool this year would see a record high.

One of the focuses of bilateral talks during the 2-day forum is the Australian call for China to reduce its import tariffs on Australian wool.

Cook also suggested that China tap Australia's abundant and inexpensive energy resources.

He estimated that China would have an iron and steel gap of at least 20 to 30 million tons by the end of this century.

"Joining with Australia now, to have early stage energy intensive processing carried out in Australia would be one of the most efficient ways available for China to plug this gap," he said.

He added that Australia's service businesses are also ready to enter the Chinese market with higher momentum.

Australian Telecom Firms Increasing Sales

40100108B Beijing CHINA DAILY in English 9 Sep 93 p 2

[Article by staff reporter Wang Yong]

[Excerpt] Australia's telecommunications companies are charging into the Chinese market.

Visiting Australian Trade Minister Peter Cook yesterday launched the Australian Telecommunications Capabilities Statement to raise the profile of the sector's performance in China.

Cook initiated the statement in Beijing at a 2-day economic forum between China and Australia that ended yesterday.

The statement was unveiled against Australian predictions that China would invest $12 billion by the year 2000 to install at least 33.6 million phone lines.

During his visit to China from September 6-14, Cook plans to witness the signing of several agreements between Australian companies and Chinese authorities.

The Australian Stanllite Electronics Pty Ltd will sign a letter of intent with a government authority in Zhejiang Province to supply a private cellular mobile telephone system.

Ericsson Australia will sign a contract for putting in extensions on the Ningbo telephone network.

The company also plans to sign a contract with the Sea-Port Bureau for a new telephone exchange in the port area, and a frame agreement with the Ningbo Post and Telecommunications for 400,000 lines of telephone exchanges over the next 5 years.

Alcatel Australia Ltd has clinched a deal to sell $14 million worth of telephone exchanges to Heilongjiang.

On Tuesday, Australia's leading telecommunications company Telstra signed a joint venture agreement with China Aerospace Corporation's research institute to develop satellite system technology. [passage omitted]

Research Report on China's High-Tech Management System Reform

93FE0713A Guangzhou KEJI GUANLI YANJIU [STUDIES IN S&T MANAGEMENT] in Chinese No 2, Mar-Apr 93 pp 14-17, 34

[Excerpts from research report on "China's High-Tech R&D Management System Reform Plan and Design" by Li Guoguang [2621 0948 0342], Chen Yisheng [7115 4135 0581], and Hou Yimin [0186 6654 3046] of the Institute of S&T Policy and Management Science, Chinese Academy of Sciences]

[Text] Today China is engaged in extensive reform for establishing a socialist market economy system. The

central problem has been the relationship between planning and the market. This involves both theoretical understanding and practical implementation; it requires continual investigation.

The reform of the high-tech management system must be carried out in a systematic and phased manner. In the 1990's, we should encourage the entry into the market economy and reform of the management system. At the same time, we should never neglect the investment and supervision of the state. The government should establish a special management organization to formulate evaluation system and R&D projects.

One Scenario

The reform of China's high-tech R&D management system should be based on reality so that the planned management can play a macroscopic role of moderation and that the economic benefits can be improved.

We should continue to search for weak links in the management system and take remedial measures. Examples are the proof and evaluation of projects and the coordination between the technical system and the administrative management. Our general concept is that the Academic Council of the Chinese Academy of Sciences should play the final consultation role in the decision of high-tech R&D projects in China and that this function should be strengthened. Once a project has been proven and established, it should be executed by the expert committee in the State Science and Technology Commission. We should consider letting the State Planning Commission evaluate high-tech R&D results in order to promote the growth of the high-tech industry.

The current economic system in China is a combination of planning and market. The management system for high tech should follow this direction and practice a combination of planned management and market guidance.

1. Planned Management

Based on the experience and lessons from the last 40 years, high-tech management should first and foremost be unified and centralized. In terms of government offices, the State Council is the first level of management and is responsible for policy-making and for guiding all high-tech R&D activities in China through the high-tech planning and coordination groups.

The decision-making must be democratic and scientific. The Academic Council of the Chinese Academy of Sciences, while playing its consulting role for major policy decisions regarding China's science and technology, should also be the highest advising and consulting organization for high-tech R&D. The day-to-day activity of the council should be conducting studies on the national situation, understanding development trends in S&T, carrying out macroscopic strategy studies and proofs of major projects.

After a policy is formed, the state must adopt high-tech R&D command projects (such as the "863 Program") and guiding project for industrial development (such as the "Torch Plan") and organize the implementation of high-tech R&D through the experts committee.

(1) The state Science and Technology Commission shall form the experts committee with members selected from the government, the academies, industries, universities, and the military system.

(2) The role of the experts committee is mainly technical command but the committee will also assume part of the administrative function. The experts committee should organize and coordinate the subjects of projects, plan formulation and execution, fund allocation, the selection of research organization and personnel, regulation establishment, the acquisition, importing, and assigning of equipment, the exchange of information and the handling of research results.

(3) The experts committee is led by the head expert and has four levels. Below the head expert there are subject expert group, special topics group, and tasks group.

(4) The experts committee shall open the projects for bids and shall review the submitted bids and make an award. The relationship with the project leader and the host department shall be defined by a contract or work statement. The leader of the host unit must be involved in the conversation and sign off on the contract. The administrative system shall practice "projects in the vertical direction and management in the horizontal direction." A portion of the funding may be allocated to the host department.

(5) The experts committee should have a permanent office and the day-to-day business should be handled by a management cadre. The committee should have a foreign affairs group.

(6) Flexible research centers may be formed for special disciplines. The flexible centers are mobile research units affiliated to a certain research institute and are only nominally independent. They will have their own offices, experimental equipment, service facility, and office expenses under their control. They will pay the wages of their employees but they will not establish their own accounts. The personnel of a flexible center are highly mobile so the center must have apartments.

(7) Although the policies must be scientific and democratic, the execution must be carried out by special personnel. The division of jobs must be clearly defined and the management system must be complete and rigorous. There should be mechanisms for periodic review, monitoring, and inspection.

High-tech R&D projects should be carried out by basic research organizations, science colleges, applied research institutes, engineering colleges, and high-tech enterprises. The research results should be developed as much as possible. This would require high-tech development and industrial plans. These plans should be implemented through applied research institutes, engineering colleges,

and high-tech industry. The high-tech plan must be linked up with State S&T Key Tasks Program and relevant development plans for coordinated development. Therefore, the State Planning Commission should have an experts appraisal committee.

The experts appraisal committee should consist of experts selected from the government, the academies, the financial institutions, the economic sector, the environmental protection departments, the industry, the universities, and the military engineering system. The main function of the committee will be to evaluate the technological and economic feasibility of high-tech R&D results, and to promote the industrialization and commercialization of high technology.

2. Market Orientation

High-tech development and industrial plans, being guiding plans, are different from research plans. The development results must be commercialized and the best approach is through the market-oriented high-tech research parks and enterprises. A good example is the S&T enterprises in the Beijing New and High-Tech Industrial Development Zone. This is a new management system that converts high-tech research results into development.

S&T enterprises, also known as high-tech enterprises, are totally different from the old mode of scientific research. They establish their own R&D projects based on market needs, raise their own money, form their own staff, and compete on the market as product manufacturers and vendors. They survive and grow by searching out sales targets and accumulating more capital.

Since the founders and operators of S&T enterprises are mostly experts in their own fields, they have a keen understanding of the technical situation and development prospects of the field. This makes them better in grasping the market message and seizing the initiative in the complex competition. The market-oriented economic entity combining technology, industry and commerce, and backed by technology development is a healthy cycle of "market-information-development-product-market." It is an operating mechanism that engages the market, adjusts to the market, relies on the market, and depends on the market.

Here time is money. Bureaucratic red tape and procrastination of the old S&T system are not allowed. Low efficiency and high consumption are also fatal flaws. They must assume full responsibility for their own action and for the risks. For this, they must have nimble reactions and high efficiency.

Science and technology enterprises should establish a market-oriented competition mechanism, that is, an operation mechanism conducive to product manufacture competition. The mechanism shall include independent policy-making, flexible operation mechanism with fast reaction, a personnel transfer system that makes optimum use of the talents, a distribution system linked to economic benefits, and a morale boosting mechanism centered on the establishment of an enterprise culture. By so doing, S&T and the economy will be tightly coupled and the process of transferring high-tech results into productivity will be greatly accelerated.

In the high-tech park, high-tech enterprises started by large national research institutes and by civilian organizations, and new-tech enterprises formed by lateral union all operate with their own flexible system and play their own role. There is no longer a unified organization model and they may be called companies or research centers and institutes.

Once an enterprise in the high-tech park is recognized as a high-tech enterprise, it will enjoy high priority in review, simplified paperwork, and reduced or waived taxes. To facilitate import and export, the customs office may have a branch office in the park. To facilitate the raising of capital, banks may support new-tech enterprises with loans and form venture capital or venture investment companies. To facilitate foreign trade, new and high-tech product import and export companies may be established in the park. To enter the market, an enterprise may set its own trial sales price. To make better use of the talents, S&T personnel are encouraged to lead the start of new and high-tech enterprises. When the original job allows, S&T personnel may take on second jobs.

Large research institutes should continue to explore opportunities for starting high-tech enterprises. When the property right relationship is clearly defined, they may establish a management system based on the principle of stockholding. Large research institutes may become stockholders by counting their research results as equivalent purchase prices for stocks. They may also develop high-tech products by collaborating with foreign investors in order to start high-tech enterprises with international competitiveness.

The organization of S&T enterprises should depend on the division of property rights. If an enterprise consists of investments from several units, it can generally be managed by a general manager led by a board (management committee) based on goals set for various levels. The president (or general manager) should practice a targeted contract responsibility system in relationship with sub-companies and branch companies.

The scenario described above is a gradual reform of the original S&T system. Although it makes a preliminary linkage between planned economy and market economy, the linkage is mechanical rather than organic and the system is not institutionalized. For the existing organizations, it is insufficient to merely improve their functions; they need assurances with regard to institutional reorganization. For example, they need avenues for investment and promotion of high-tech results. Furthermore, research and development have different values orientation and different rules of operation. Therefore, there are often conflicts in personnel management and distribution. There are serious flaws in the above scenario and improvements must be made in organization.

Another Scenario

In view of the limits of the first scenario of China's high-tech management system reform, we propose the second scenario as a further reform of the middle and lower level management system.

1. Reform in the Ministry and Commission Management Level

To adapt to modern high-tech R&D development and the promotion of S&T and economy, the ministry and commission level management system must be reformed. First, the functions and responsibilities of the ministries and commissions regarding high-tech R&D management must be clearly defined. For example, projects may be established at the State Planning Commission (including the establishment criteria and the application and review procedures) and the business management may be conducted by the State Science and Technology Commission. In addition to the policy-making, consultation, planning, management, and evaluation systems proposed in the first scenario and the existing specialities, management and monitoring functions of the ministries and commissions, considerations should also be given to the establishment of the following organizations.

(1) High-tech financial organization. The main functions of this organization will be to collect research results from people-owned research institutes and to provide the financial resources needed for creative activities. It will in essence be a government-run investment company. The support it provides will promote the reduction to practice of research results. In the meantime it also assists and promotes product development in high-tech enterprises.

(2) High-tech application and promotion organization. This organization provides high-tech research results to high-tech enterprises established by government and civilian S&T organizations; it is also the organization that implements the technology development policy. It is responsible for organizing and implementing large-scale development projects, and promoting future industrial development. Its activities will promote cooperative research and serve as a bridge between R&D and industry. Military technology should be transferred to civilian use after declassification. The military-to-civilian technology transfer can not only broaden the impact of the high-tech project but also supplement the shortage of funding for defense research projects.

For the military, the functions of such institutes are: 1) In planning the projects attention should be given to the investment of dual-use and generic research projects. 2) In the design and manufacture of defense products, there should be a link among scientific, military and industrial communities in order to explore dual use possibility. 3) In sending defense projects out for bids, consideration should be given to possible civilian development. 4) After defense research results are evaluated to be of commercial and industrial value, they should be actively transferred to the enterprises so that the defense research institutes may become the sources for high technology.

On the side of the Chinese Academy of Sciences, the State Education Commission, and other industrial departments, there should be corresponding activities for applying and promoting high technology in the form of engineering research centers and high-tech industrial development centers.

(3) High-tech information organization. This organization will be a technology data bank that serves various users. Users of the data bank with defense approval receive the service for free. By linking to the information system, a user may have access to declassified technical data on materials, information, automation, new energy and other fields. When classified technologies are involved, the user may apply to high-tech application and promotion organizations.

(4) High-tech consulting organization. Consultants of this organization will reside in various universities, research institutes, and technology companies. The consultants will be devoted to technological development projects and may provide consultation on declassified technologies.

The purpose of having these organizations is to combine the state planned management and the market readjustment and to promote combination of distribution and centralization. China should develop its high technology by gradually moving toward policy guidance (such as the enterprise technology advancement policy) and organized management. The government should invest only in areas with strategic importance.

2. Unification of Research Institutes and Industry

The establishment of the above-described organizations is a reform in the second level. To realize the high-tech R&D management system proposed in the second scenario, there must be reform in the third level, namely, the unification of high-tech R&D and industry.

The third level management involves mainly the Chinese Academy of Sciences, ministerial commissions in the government, research organizations in universities, and the flexible research centers proposed in the first scenario. Today, most of them belong to the state-owned units and operate at the command of the government. Also involved are market-oriented S&T enterprises and civilian research institutes (i.e., technology companies) that enjoyed rapid development in recent years.

To this end, we should categorize and combine the state control (or unification plan) with the flexible mechanisms of high-tech enterprises so that the promotion of the state-controlled plans may be joined with the market force. With the exception of basic research and public service research, more operating methods of the high-tech enterprise should be introduced into applied research and development and high-tech R&D. The previous situation of research divorced from economy and production must be changed. The old rigid Russian model of state monopolized high-tech R&D system must

be changed and the new agenda should be set through management jurisdiction and internal organizational structure.

In the third level management, the business department should be divided into a research department and a development department, each with its own clearly defined mission. They should be different but related.

One of the main functions of technological renovation in a research institute is policy-making. The operation and management authority of a research institute should be given to its development or research department so that the management level becomes the order of research institute → research department and development department → projects section and contract section.

Results from the research department will be transferred to the high-tech industry via "incubator centers" or engineering research centers. The products may enter the market directly or re-transferred to the manufacture enterprise and changed into economic mass production. Results from the development department are transferred to the manufacturers via intermediate testing or intermediate organizations. The development department itself may form companies or plants or it may team up with the manufacturers and form consortia.

S&T incubator centers should help small-scale high-tech enterprises by providing office space with low rental fees, secretarial service, communication and computing facility, and consultation on technology, legal and management information. In addition, the incubator centers will also provide the necessary capital (such as innovation companies or patent offices). An enterprise must leave the incubator center after it has reached a certain business volume in a certain time period so that new enterprises may take its place.

In addition to strengthening intermediate testing between the research organization and the manufacturing enterprise, there may also be a strong intermediate organization that includes foundations, investment banks, innovation companies, and market sales departments. This organization consists of experts knowledgeable not only in manufacturing technology but also in market. Its main mission will be to conduct feasibility study, project evaluation, management consulting, market survey and forecast, information exchange, high-tech promotion to develop a product market needed by both high-tech and users.

The intermediate organization should be a bridge between the government and the high-tech enterprises or manufacturing enterprises. The investments of the government often work through the intermediate organization.

In addition, the enterprises should form the necessary special function organizations and a technology advancement operating system in order to realize the effects of high-tech on the national economy and to avoid the interference of technological advancement by the day-to-day production operation. Such professional organizations may include research consulting organization (i.e., overall idea and overall design departments), technological development organization, special offices in charge of technology renovation, and offices in charge of planning and coordination. The main functions of the professional organizations are technological advancement planning, project transition, and the balance and control of capabilities and funds. These professional offices will help the organizational system consisting of design, implementation and control departments and the project network consisting of various planning and technology advancement projects to form a working system. They will ensure that technology advancement is included as part of the long-term operation. Today many large and medium-sized enterprises are practicing the chief engineer technology responsibility system; their experience should be consolidated.

With the implementation of the second scenario, it will be possible to unify planned guidance and market modulation.

Measures for Readjustment of R&D Structure Proposed

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[Article by Li Xinnan [2621 2450 3948], China Center for the Promotion of Scientific and Technological Development: "Some Ideas for Readjusting China's Research and Development Structure"]

[Text] 1. China's economy is entering a new stage, the course of the socialist market economy has become clear, enterprise management systems are being transformed at an increasing pace, the small-government-large-society model is gradually taking shape, and reorganization of the government's functional departments is about to begin. On the other hand, the increasingly intense international competition centered on science and technology and the constant change in the international political situation increasingly compel us to make thorough use of science and technology as primary productive forces and to employ our limited resources to accelerate the pace of economic modernization. It is essential that we adapt to the new circumstances, make scientific and technological reform even more thorough, and use the organizational system to optimize the allocation of S&T funding.

As a result of a long period of studies and practical efforts aimed at eliminating the faults of the existing system, such preliminary steps as opening up technology markets and the funding system have largely been implemented in the R&D sector, and China's S&T personnel are deployed in the three strategic hierarchies, namely, the main battlefield of economic development, high-technology research and the development of high-technology and new-technology industries, and basic research. But the fundamental arrangements for integrating S&T with the economy have not yet been made, and as a result the situation still does not promote the

consolidation and development of already completed reforms or the optimum allocation of resources for science and technology. Consequently, as the integrated reform of China's economic system becomes increasingly thorough, readjusting the research system has become a key task in the reform of the S&T system and in ultimately establishing a new type of S&T system.

The 14th Party Congress stated expressly that the objective in reforming China's economic structure is to establish a market-oriented socialist economic system. This objective defines the orientation of the reorganized R&D system that we wish to create. In previous reform efforts, changes in the operating machinery brought numerous market factors into the research structure and caused the commodity economy and market-oriented thinking to become solidly established, thus laying the groundwork for the establishment of a new market-based R&D system. Thus we must push forward with the reform, judiciously but rapidly, and reorganize the R&D system.

2. At present there are 5,416 research and technology-development organizations under universal popular ownership at the county level and above (for brevity, we shall refer to them below simply as "R&D organizations"); they employ 1.01 million persons, including 390,000 scientists and engineers, and have a total operating budget of 18.7 billion yuan, of which government allocations account for 8.1 billion yuan. Among these organizations, 1,071 are affiliated with departments of the State Council: they employ 580,000 persons, including 240,000 scientists and engineers, and have a total operating budget of 1.22 billion yuan, of which government allocations account for 39.8 percent; and 123 organizations are subordinate to the CAS, employing 68,000 persons, including 38,000 scientists and engineers, and having a total operating budget of 1.4 billion yuan, of which government allocations account for 974 million yuan. In addition, there are 414 sectorial S&T information and documentation organizations at the county level and above, which employ 210,000 persons, including 140,000 scientists and engineers, and have a total operating budget of about 400 million yuan, of which 290 million yuan consists of government funding.

The activities of the above organizations fall into four large categories: basic and applied research, technology development, social welfare, and S&T service activities. But for historical reasons and as a result of changes in administrative systems and horizontal and vertical expansion of the tasks of these organizations, past statistical data do not enable us to distinguish these four types of activity, particularly in the case of large academies and institutes subordinate to State Council departments and to the CAS. Thus, the existing data can provide statistics only on certain categories of activity.

By analyzing available statistics and making calculations with internal data that became available, we have been able to construct the following general picture.

Locally-subordinate R&D structures generally fall into the technology development, social welfare, and S&T services categories, with the social welfare group accounting for about 51.2 of the total and the technology development structures for about 42 percent.

—Of R&D organizations subordinate to State Council departments or the CAS, (1) about 80 organizations devote between 20 and 50 percent of their activity to basic research (including 32 that are directly subordinate to the CAS); they have about 31,000 employees and a combined operating budget of more 500 million yuan, of which 300 million yuan is provided by government funding; (2) about 386 organizations are engaged primarily in technology development; they employ a total of 550,000 persons and have a combined operating budget of 880 million yuan, of which government funding provides about 500 million yuan; (3) there are about 90 S&T service organizations (including 36 information and documentation organizations, some subordinate to the CAS), with a total of 40,000 employees and a total operating budget of 370 million yuan, of which government funding provides 230 million yuan.

It is evident from the above data that government funding of science and technology is limited but maintains a huge S&T contingent. The government's category-by-category investment policy actually loses its focus as a result of imprecise classification of research organizations and by overlap of types of activity; this dissipation of limited S&T investments is becoming increasingly out of control. The above facts indicate that structural readjustment faces two difficulties at the outset: rigid constraint by the departmental ownership system, and imprecise classification and category overlap of the scientific research organizations.

3. Under current conditions, there are two choices in readjusting the R&D mechanism. The first choice, direct readjustment, consists of using administrative and economic measures to support the development of some organizations while weakening or making drastic changes in others. To use this method, it would be first be necessary to coordinate it with the departments and arrive at unanimous agreement, or to wait for the appropriate time for departmental reorganization; in addition, an effort would have to be made to arrive at an effective classification of the research organizations in terms of their activities.

In the other alternative, indirect readjustment, no direct alteration of the system is undertaken, but shifts in the focus of government S&T investments and the creation of a diversified development policy are used to induce the scientific research organizations to pursue divergent activities by their own choice. To use this method, we must first specify clearly the government's functions in the research field and state what it will and will not do; second, the financial resources that the government is able to supply at particular times must be used to specify priority development fields and define the focus and extent of management; third, a government S&T funding

model that promotes fair competition must be established; and fourth, the organizations that do not receive funding from the government must be given full autonomy to develop as they see fit.

Of these two alternatives, the first is simpler, but will collide directly with the rigid constraints of the departmental ownership system and with the imprecise categorization and functional overlap of the research organizations, and its implementation may cause rather large fluctuations in production. The second alternative is more complex and will require a change in the functions of the S&T management departments, but it avoids a direct collision with the above two problems and it may be implemented by a stable, natural transition.

Based on past reform experience, the objective laws that govern the integrated development of S&T and the economy, the overall objectives of China's economic and S&T reform, and with international experience with R&D systems, we conclude that China's objective in readjusting the R&D system should be to create an S&T organizational structure that is consistent with a socialist market economy, that will promote sustained, efficient development of the national economy, and that will help to consolidate the country's position in international competition. Its specific components are as follows:

—A High-Quality, State-of-the-Art Scientific Research System

The main tasks of such a system are to carry on scientific research relevant to long-term progress in science and technology, the economy and society, and to engage in S&T activity that produces social benefits, including basic research, high-technology research, and breakthrough efforts in the key S&T aspects of major engineering projects and research programs. The state will provide financial assistance through direct capital investment, project funding by foundations, and state procurement of research results, in order to assure that S&T personnel in the system enjoy good research conditions and a good standard of living. The national scientific research system should consist of personnel involved in basic research at state laboratories, state research centers, and advanced academies and schools, and its operating machinery should be open, mobile, competitive, and cooperative.

—A New Style of Enterprise-Based Industrial R&D System

The main tasks of this new system are to support enterprise S&T advancement, to cooperate with the scientific research system in transferring and disseminating research results, to create technology and to develop innovative products, to consistently convert S&T results into productive forces for industry, and correspondingly, to set technological standards that will assure the modernization of industrial production. The enterprise will be the main development and investment element in the activity of this system. The state will exercise guidance by investment loans and discounted loans for key projects and by its industry policy and technology development policy. The industrial research and development system will organize and carry on market activity via enterprise and consortium research organizations, industrial technology development organizations under all types of ownership systems, regional technology development bodies, and unaffiliated engineering technology centers and production promotion centers.

—Rural Technology Development and Dissemination Support Systems Based on Integrated Technology-Agriculture-Commerce and Technology-Industry-Commerce Organizations

The main tasks of these organizations will be agricultural technology development, demonstration of applications, training, dissemination, and the provision of technology-based support for converting the agricultural production process to series production and socializing it. Their funding will come primarily from compensated services and diversified operations, assisted by central aid in accordance with state support policies. The state will exercise guidance via special research topic subsidies, investment in key projects, favorable loan terms, and development policy. The rural technology development support system will consist of a small number of rural technology development centers, a variety of integrated technology-agriculture-commerce or technology-industry-commerce organizations, specialized technology contracting groups, regional technology development contracting groups, peasant technology associations, research associations, and rural technology support services networks, to promote the market machinery.

—An Internationally Competitive High-Technology and New-Technology Industry

Its main tasks are: to engage in industrial development of high-technology and new-technology results and to work for their conversion to commodities and industries and their internationalization. The state will support the development of this industry by means of priority loans and venture funding and will exercise guidance via industry policy, technology development policy, and the appropriate taxation and finance policy. The new S&T industries will consist of integrated technology-industry-commerce bodies run under various ownership systems and in various areas of society and will operate in accordance with international practice and the market mechanism.

4. The readjustment process is in actuality a process of conversion from an old system to a new one. The readjustment cannot be achieved in a single step: new S&T organizational structures can only be built gradually while the original system continues to be in force, and they must also be implemented concurrently with and in coordination with reform in the economic system and similar areas: this is why readjustment is so difficult. In view of the exploratory nature of reform and the imbalance in the development of the various industries and regions, the difficulty of carrying out coordinated

reform of all aspects, and the limits of people's psychological capability to tolerate readjustment, the effort to readjust the research and development structure must take the approach of "advancing area by area, local breakthroughs, and step-by-step advance."

—Advancing Area by Area. This means dealing with the actual circumstances of different industries, different fields and different geographic regions by developing different reform requirements, motivating the departments and localities, and establishing a variety of locally appropriate pilot reform sites, areas, and industries, so that they involve into a network, support and influence each other and "cross-radiate."

—Local Breakthroughs. This means focusing on the difficult points of reform and concentrating one's best capabilities and resources for bold experimental activities, with the expectation of overcoming difficulties and gaining experience.

—Step-by-Step Advance. This means proceeding judiciously, not expecting to achieve complete success at the first effort, devoting due attention to interlocking and coordination of reform in the economic sphere and elsewhere, being prudent but persistent, and implementing objectives stage by stage. In the course of reform, we must foster and develop the elements of the new system, make timely use of policies and regulations to consolidate the results of reforms, proceed steadily and surely, and consolidate at every step.

To implement the objectives described above, readjustment activities in the R&D system can be carried out in three steps: the first step (1993-1995), consisting of preparation and pilot implementation; the second step (1996-1998), in which the framework for the new system is installed; and the third step (1999-2000) in which the new system is consolidated and perfected.

The first step comprises the final 3 years of the Eighth 5-Year Plan, during which, based on the current pace of reform, the primary focus will remain the thorough reform of the scientific research system and a continuing effort to have personnel diversify appropriately into the three strategic hierarchies, while at the same time vigorously organizing a variety of spot experiments with the objective of gaining experience and demonstrating principles, thus preparing the way for a comprehensive framework for the new system. At present we must vigorously implement the spirit of the document "Some Views on Personnel Diversification, Structural Adjustment and More Thorough S&T System Reform" and use policy guidance, the attracting force of markets, typical demonstration projects and the motive force of public opinion to implement them thoroughly.

The second stage (1996-1998) comprises the first 3 years of the Ninth 5-Year Plan, in which, building on the preparations and pilot projects, we will strive to set up the framework for the new system. Macroscopic management will proceed in terms of the Ninth 5-Year Plan specifications; funding guidance and policy guidance will be used to promote the new system, and new improved laws and regulations dealing with the new R&D system will be instituted.

The third stage (1990-2000) comprises the last 2 years of the Ninth 5-Year Plan. Building on work during the first two stages, we will promote the standardization and legislative embodiment of the new R&D system and will take administrative measures to readjust research organizations that do not meet the requirements of the new system.

For activities in the near term, the following points of departure merit consideration:

—Readjusting Macroscopic Management. Government departments involved in S&T management at all levels must further continue to alter their functions in accordance with the spirit of the Fourteenth Party Congress and must make an effort to establish a management model that is in keeping with the new R&D system. They must begin by adjusting their management thinking and link development and reform more closely together. Next, they must adjust their management methods, changing over from management based primarily on administrative measures to adjustment and regulation based primarily on policy methods and economic methods; existing plan-based funding must be converted to special-project fund grants. As an example, the establishment of a Spark Plan fund might be considered. In the future, government payments will be made under the contract system, so that the economic relationships between the government and the recipient are clearly specified and the situation with regard to administrative subordination is changed. Third, they must readjust the orientation of government S&T funding and make thorough use of the guidance effect of S&T funding, assuring that it is coordinated with policy guidance and is consistent with the alteration of government functions. In the future, S&T funding must be concentrated primarily in three areas: (1) construction and development of a state S&T research system; (2) key projects related to rapid development of the national economy; (3) funding designed to guide the economic and scientific advancement of the national economy. Adjustments related to these three areas may be made in the Eighth 5-Year Plan, and the three orientations must be fully implemented when drafting the Ninth 5-Year Plan. Fourth, an effort must be made to readjust and improve the relationships of the S&T management departments with other management departments so as to form a unified macroscopic system to manage S&T progress.

—Expand the Operating Autonomy of All Types of R&D Organizations. We should permit research academies and institutes to select their directions of development within their subject areas in accordance with their own conditions and the development requirements of the socialist market economy. We must permit the research academies and institutes to draft their own internal personnel utilization systems, distribution systems, systems of job titles and duties, and the like.

—Create a Policy Environment that Promotes Diversified Development of S&T Organizations. During the changeover from the old system to the new, diversified development of scientific research organizations is essential. It also is a major way of implementing personnel diversification and structural readjustment. As a consequence, our policy must permit research organizations to operate concurrently as incorporated service and enterprise organizations for a certain period of time, give them special treatment in the industrial-commercial, taxation, and management areas and in terms of circulating capital allocations. We must permit the research organizations to set up a variety of operating bodies, to engage in various types of economic cooperation with domestic and foreign enterprises and other corporate organizations, to and operate all types of services that promote the development of productive forces.

—Concentrate the Best Capabilities in Spot Experiments. While continuing to implement vigorously the pilot tests of high-technology and new-technology industrial development zones and "cities for integrated and coordinated reform of the S&T and economic system," we may also carry out other spot experiments such as: (1) pilot tests in state laboratories dealing with mobility, openness, competition, and coordination; (2) the organization of groups of research organizations with strong basic research capabilities into state scientific research centers and state research organization pilot projects; (3) spot experiments with the development fund system or the establishment of special topic-area funds; (4) pilot experiments on integrated reform of the "three principles of openness" in research organizations (increased operating autonomy of the organizations, with openness of the personnel utilization system, of the distribution system, and of the duties and job titles system); (5) pilot tests of the sale of stock by technical and economic entities set up by research organizations and the development of S&T consortia; (6) internationalization experiments involving research organizations, in which the participating organizations are given the right of external cooperation, including recruiting research personnel of foreign nationalities, the sale of stock for the creation of new research organizations, development organizations, high-technology and new-technology companies, and independent ventures, and the creation of overseas research windows, technology management networks and technology development companies; (7) spot experiments in large-area land contracting by agricultural S&T organizations and the development of agricultural production consortia to serve as a development base for the concentration of agriculture; (8) spot experiments by organizations in the S&T services category involving categorized management and the development of consulting businesses and information services.

Plans To Bring China Into World's Top Ten S&T Powers by 2010 Laid Out

93FE0714D Shanghai JIEFANG RIBAO in Chinese 14 May 93 p 6

[Text] Vice Minister of State Science and Technology Commission Zhu Lilan currently addressed the 1993 national S&T working conference, stating that China will establish a S&T system which can adapt to and promote the development of the socialist market economy, and will fully liberalize and develop the primary productive forces of S&T, strive to bring China into the world's top ten S&T powers by 2010, and conserve sufficient achievements and reserve strength for China's S&T development and rapid economic growth for the next century.

Representing the State Science and Technology Commission, Zhu Lilan pointed out the following key S&T tasks that need to be carried out:

1. The "Ninth 5-Year" S&T development plan should be formulated according to the new demand of national economic development, and each project under the S&T development plan should be revised so that it is consistent with the market economy. We should target precisely the leading industry in the 21st century and thus design plans for earlier stage S&T development. Strengthening the industrial policies by combining new industrial policies to identify key fields for industrial development and advancement to provide technical support for sustainable national economic development. Experts from every field should be organized to give advice on economic development for all governmental bodies. Through the study of "soft" sciences, scientific proof will be made to support the formulation of economic growth strategy and promote more scientific decision of policymaking.

2. According to demands at various levels of economic development, China will focus on the weak economic development areas and key industries, and organize concerted efforts on key technologies which may have significant impacts on economic development.

3. China will integrate independent research and development with technology imports and absorptions to effectively participate in industrial technology innovation and engineering construction, and push the advanced and matured S&T achievements for further technological innovation for promoting industrial technology advancement.

4. China will emphasize on solving key technical issues which may have significant impact and may generate high profit to provide a technical thrust for agricultural development, and link the implementation of the "Spark Plan," to direct township enterprises in promoting technology innovation and managerial advancement.

5. China will expedite the development of high-tech industries, and strive to realize the goal of roughly 10 percent of the total industrial output to be produced by high-tech industries by the end of this century.

6. China will promote the technological advancement of the Tertiary Industry, push the development of the burgeoning Tertiary Industry which is related to technology advancement; expedite the conversion of S&T achievements and extend technology achievements' scope of application, profit and scale; reinforce science work that promotes social and technical development, guide the economy to develop in harmony with the society; and further promote international S&T cooperation and exchange which are closely related to China's S&T and economic development.

'S&T Development and Military Affairs' Seminar Held in Beijing

93FE0714C Beijing RENMIN RIBAO in Chinese 20 May 93 p 1

[Article by Xu Jingyao [1776 0079 6460]]

[Text] The "S&T Development and Military Affairs" seminar held by the PLA [People's Liberation Army] Headquarters of the General Staff and Beijing Military Garrison was attended by Central Military Commission Vice Chairmen Liu Huaqing and Zhang Zhen.

The seminar started on 29 April under Central Military Commission's guiding principle that high-ranking military officials must take the lead to study modern technology. Central Military Commission officials have paid close attention to the seminar. Jiang Zemin himself has also attended the seminar and listening to attendants' feedbacks; and other Central Military Commission officials also attended the seminar and provided guidance. High-ranking officials from major garrisons in Beijing have actively participated in the seminar.

Central Military Commission member and Chief of Staff of the General Staff Department of the People's Liberation Army Zhang Wannian pointed out during the seminar's closing session that Chairman Jiang Zemin has repeatedly stressed the importance of all levels within the military leadership, especially the high-ranking officials, to undertake the study of science and technology, and to strive to master more modern science and technology know-how to fully qualify themselves as modern military commanders. To strengthen the study of modern science and technology is also an important component of Deng Xiaoping's new-era military construction agenda. All levels of leadership and administration, especially the high-ranking leaders and administrative bodies, need to treat the study of modern science and technology as a long-term task, which should be carried out uninterruptedly, fundamentally transforming leadership's knowledge and nurturing qualified modern military commanders. Not only should we pay close attention to today's study, it is even more important to pay close attention to future studies, to organize orderly and systematically all military leadership to study modern science and technology, and to form a conducive system and atmosphere that can be sustained. It is also imperative to relate closely to practice, integrating the study of modern science and technology closely with the implementation of Central Military Commission's new-era military construction guiding principles.

List of State Engineering Research Centers Established

93FE0717B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 28 Apr 93 p 2

[Article by reporter Jing Xianfeng [2529 7145 1496]; cf. JPRS-CST-93-003, 2 Mar 93 p 1 and JPRS-CST-93-009, 13 May 93 p 9]

[Text]

1991 (1st Group) 30 State Engineering Research Centers (SERC)

Computer Integrated Manufacturing System (CIMS) Test (SERC)
ASIC System SERC
ASIC Design SERC
Data Communications SERC
Flat Panel Display SERC
Solid-State Laser SERC
Metal-Matrix Composite Materials SERC
Magnetic Materials SERC
Resin-base Composite Materials SERC
Fiber-reinforced Modular Plastics SERC
Carbon Fiber SERC
Organosilicon Applied Technology SERC
Impact-Structure Plastics SERC
General Engineering Plastics SERC
Liquid Separation Membrane SERC
Reaction-injection Forming SERC
Synthetic Fiber SERC
Metallurgy Automation SERC
Electric Automation SERC
Special Pumps and Valves SERC
Water-coal Slurry SERC
New Energy Resources SERC
Clothing Design and Processing SERC
Nonmetallic Ores Deep Processing SERC
Comprehensive Use of Nonmetallic Ore Resources SERC
Urban Water Supply and Drainage SERC
Urban and Highway Transportation Management SERC
Vegetable System SERC
Changping Comprehensive Agriculture SERC
Yangling Comprehensive Agriculture Test SERC

1992 (2nd Group) 9 SERCs:

Parallel Computer SERC
Architecture SERC
Industrial Architecture Diagnosis and Remoulding SERC
Catalysis SERC
Carbon Chemistry SERC
Special Fiberglass and Fiber Products SERC
Industrial Controls Unit-Installations and Systems SERC
Medical Treatment and Protection Equipment SERC
Forest Products Chemistry SERC

Research Association Established To Promote Marketing Cutting-Edge Technologies

93FE0717C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 17 May 93 p 1

[Article by reporter Wang Hanlin [3769 5060 2651]]

[Text] Chinese cutting-edge technology is beginning to move into the major markets, but the industrialization of China's cutting-edge technology is still a difficult issue confronting China. This was the general opinion of the scientists who participated in the "Chinese Cutting-Edge Technology and Industrial Management Conference" on 15 May.

The Conference Chairman, Liu Jie, told reporters that cutting-edge technologies are in the high-tech category, and are on the forefront of those industries. As Qian Xuesen once said, "They are critical to socialist construction, and China must launch an all out attack for those technologies."

In the early 1950s, China made rapid progress with relatively little input, and got the technologies for the atomic bomb, hydrogen bomb, missiles, and man-made satellites, and promoted the development of other new technologies and industries that go along with that, which made China one of the few countries in the world that have a good grasp of nuclear and space technologies. Since 1986, China has implemented the "863 Plan" and the "Spark Plan;" and China's defense S&T industries adjustment policy made the implementation of conversion of military technology to civil-use available; the burgeoning of high-tech industrial development zones, and technical markets has opened up new channels to commercializ and internationalize the high-tech achievements, opening up markets, and form new industries. Many impressive achievements were made in cutting-edge technologies, such as the electron-positron collider, application satellite, super computers, nuclear power, fiber-optic communications, lasers, infrared, superconductors, biology, and bio-chemistry.

Liu Jie believes that industrialization of cutting-edge technologies and modernization of their management are the two key issues that the development of China's cutting-edge technology industry faces, and for cutting-edge technology to become the rising industry to move into domestic and foreign markets, there must be an appropriate support structure and management mechanism. A support structure means the support of programs, policy, administration, funds, talent, and infrastructures, auxiliary industries and special services. Management mechanism means a mechanism that promotes and defines market development, management policy, property rights, talent mobility, and a distribution system. Liu Jie also believes that because cutting-edge industry is an interdisciplinary-related science with all sorts of specialties, and a structural complexity that is fully comprehensive, and involves vast systems, the organization and management of these kinds of huge systems are definitely out of reach of the old school of management theory and practice, and to be workable they demand the aid of information theory, control theory, system theory, cooperative theory, and the whole range of modern management theories and practices.

Progress in Implementation of Establishing State Engineering Research Centers

93FE0717A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 28 Apr 93 p 1

[Article by reporter Han Yuqi [7281 3768 3825]; cf. JPRS-CST-93-003, 2 Mar 93 p 1 and JPRS-CST-93-009, 13 May 93 p 9]

[Text] The State S&T Commission has approved and will direct 39 State Engineering Research Centers (SERC) which will be established in two groups. These SERCs are off to a good start as funding for organizing and establishing them is essentially in place, and facilities are being readied in good form. This is what reporters learned at the opening of the First Working Conference on SERCs in Beijing on 27 April. Vice Minister, Deng Nan, of the State S&T Commission attended the conference.

The SERCs are being established to promote the transfer of S&T achievements into production force, and to ripen them to their fullest engineering potential. Each year, some 30,000 S&T achievements pass examination and acceptance at provincial and ministry level and above, but less than 20 percent ever come into wide use. This situation calls for the organization and establishment of SERCs and augurs for their full utility. The 39 engineering centers were selected from 200 recommendations received from departments, localities, and units. They are key S&T organizations, S&T-oriented enterprises, and higher learning institutions of robust technological engineering development in major business fields, possessing technical expertise in engineering technology R&D and design, with superior environments for full-scale experimentation in engineering technology involving a broad range of basic industries, supporting industries, new enterprises and social development.

About 400 million yuan are to be put into these engineering centers by the State, bank credits, and funds raised by a mixed bag of supporting units and departments. Funding allotments for the first group of 30 engineering centers approved in 1991, is in place as planned in the years of 1991 and 1992. Funds for the second group of nine engineering centers were allotted as planned in April of this year. Hundreds of facilities for the engineering centers have already been imported, over 100,000 square meters of laboratory space has been set up, over 60,000 square meters of space for pilot plants is built, and 20 new test production lines have also been built.

Work is progressing rapidly on a metallurgy automation engineering center and a Beijing vegetable SERC, each of which received contract funds in 1992 of up to 90 million yuan. In 1992, a liquid separation membrane engineering center already has a test production capability with an output value of 20 million yuan.

The engineering centers will operate in a form of large industrial systems. Most of them have set up advisory committees for making science policy decisions, and they will also promote exchange and cooperation with foreign counterpart industries. For example, the metallurgy automation engineering center has signed a long-term cooperative agreement with the Japanese Yokogawa Electric Corporation, and the clothing design and processing center is also beefing up its cooperation with Germany, Hong Kong, Japan, and Taiwan.

Shanghai Implements 'S&T Specialist Nurturing Project'

93FE0714A Beijing RENMIN RIBAO in Chinese 19 May 93 p 1

[Text] [Article by Xiao Guangen [5618 7070 2704] and Lu Yiping [4151 3015 1627]]—To bring up a new generation of cross-century disciplines meeting international standards and a group of leaders in the special fields of study, Shanghai City decided to implement the "Science and Technology (S&T) Specialist Nurturing Project."

It was reported that the implementation of this project would be divided into three stages. The first is to continue implementing the "Shanghai Youth S&T Elite Enlightment Project" and to train or prepare science and technology leaders who are under age 35. The second is to push for the "Post Shanghai Youth S&T Elite Enlightment Project" by selecting the top 10 to 20 percent of the successful S&T elites who have made exceptional contributions and important achievements in scientific research for follow-up training, giving them continuous education, and expanding grants for their research projects. The third is to implement the "Shanghai Discipline and Specialty Leaders' Support Project" by selecting outstanding middle-aged (about 40-50 year-old) and young scientists for undertaking key research projects to foster a transcendent group of science and technology experts with national standards.

[Article by Wang Xuexiao [3769 1331 1321]]—Tianjin City Department of Higher Education has allocated 1 million yuan special fund to hire 100 recently retired, renowned experts and professors in Beijing and Tianjin, at a high annual salary of 10,000 yuan, to direct the teaching and scientific research work of Tianjin's colleges and universities.

It was announced that such a decision is aimed at raising the level of teaching and scientific research of Tianjin's institutions of higher learning. The employed experts and professors hired under this "high salary for expertise" program are all recently retired professors and experts from teaching posts, so that they are well-experienced, scholastically advanced, and still energetic.

Young Scientists Given Priority To Receive S&T Funding

93FE0714B Beijing RENMIN RIBAO in Chinese 19 May 93 p 3

[Article by Cai Meihua [5591 5019 5478]]

[Text] Since the establishment of the National Natural Science Foundation, grants for young scholars who have received doctoral degrees under 35 years of age have increased from 3.4 million yuan in 1987 to 22.6 million yuan in 1992, with the 6 years' total support surpassing 68 million. This support has effectively promoted the rise of young scientists, giving full play to their intelligence and skills, yielding satisfactory scientific achievements.

Of the 89 initial youth Science Foundation projects in 1990, young scientists have published 648 treatises and 11 books, awarded two patents, and won six ministerial and two provincial awards for research achievements.

Meanwhile, these young scientists have been placed in important positions by colleges, universities, and other science and technology research organizations. Among those young scientists in Beijing University who have been recently promoted to the status of professor and associate professor under the age of 35, 54 persons are in charge of Science Foundation projects. The 21 young professors holding university or department leadership positions in Zhejiang University have been supported in varying degrees by the National Natural Science Foundation in their scientific research.

The National Natural Science Foundation has a series of policies which favor young scientists. For instance, when conditions appear to be similar during the process of project assessment, young scientists will be given priority to receive grants; when forming the task force for disciplinary evaluations, young scientists need to occupy a specific percentage in the task force; and when selecting candidates for overseas advanced studies and attending international conferences, more and more young scientists will be chosen.

Since the National Natural Science Foundation established a specific fund to sponsor overseas Chinese students and scholars to return home temporarily for short-term lectures, 36 applications have thus far been approved. The majority of the applicants are young scholars in their early thirties. From 1987 to 1992, the National Natural Science Foundation has sponsored 93 youth conferences and youth science education activities with total funds reaching 1.1 million yuan.

Strategic Position and Role of Space Activity in China

93FE0778A Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 5, May 93 pp 3-5

[Article by Liu Jiyuan [0491 4764 0626]]

[Text] Judging from today's domestic and international situation, the remainder of this decade will be a critical period in the history of China's socialist development toward modernization. The success or failure of the socialist system and the future of the Chinese people will directly depend on whether we can solidify and build on the achievements of the 1980's, and actively pursue economic development and social progress. The decade of the 90's will also be a critical period for China's aerospace industry. In an environment of worldwide technological revolution and intense international competition, China's aerospace industry is facing a decision to choose between one of two paths: one is to remain stagnant or slide backward, thus widening the technology gap between China and the developed countries, and giving up the hard-earned position in the international aerospace community; the other path is to maintain the momentum of aerospace development of the past decade, and to catch up with the advanced state of technology of the developed nations, thus making significant contributions toward reaching China's next strategic targets. Clearly, we should do our best to avoid the first path and strive to take the second.

I. Strategic Position and Role of the Aerospace Industry in Today's Environment

In an article entitled "Formulating and Solving Problems From a Global Viewpoint," Comrade Qian Xuesen addressed the topic of how to apply satellite technology in constructing a socialistic China in the 21st century. From a strategic point of view, he presented an analysis of the unique and essential role of aerospace technology in China's modernization. Today, the importance of developing aerospace technology is being increasingly recognized, particularly in the following three areas:

1. Aerospace Technology Is an Important Indicator of National Strength; It Plays a Special Role Maintaining China's National Prestige in the International Community

History has shown that the development of China's aerospace industry had played a significant part in elevating China's international prestige and in shaping the strategic balance of the world today. As pointed out by Comrade Deng Xiaoping, if China had not developed the atomic bomb and the hydrogen bomb, or had not launched artificial satellites in the 1960's, it certainly would not have attained the status of being one of the three major powers of the world.

In recent years, the world has been evolving toward a configuration with multiple power centers; the old bipolarized world no longer exists, but a new scenario has not yet taken shape. In this complex era of international struggle, China has become the flag-bearer of socialism and Marxism. In order to assume this leadership role, China must be backed by a strong defense and a solid economy. If we fail to develop the high technology of the modern world and play a major role in the aerospace community, then we will lose our voice as a major power. In shaping the new world scenario, aerospace technology should play a similar role as it did in the 1960's.

2. Aerospace Technology Is an Important Indicator of Productivity of an Advanced Society; It Plays an Important Role in the Effort To Reach China's Strategic Targets

The fact that many countries in the world today are making huge investments in developing their aerospace industries is clearly not driven just by political and strategic considerations. The motivating forces behind aerospace development are mainly the demands of economic growth and the social and economic benefits that can be derived from aerospace technology.

The application of aerospace technology will drastically change the method of production and the mode of operation in many areas, thus significantly raising the productivity of the society. For example, in China, the use of marine satellites can increase the productivity of the fishing industry by 13 percent; the use of satellite to regulate electric power can increase the total power supply by 3 percent; the use of satellite to coordinate financial transactions can double the speed of circulation of funds. In addition, the use of application satellites in the areas of agriculture, forestry, petroleum, geology, transportation, communication, land-use planning, environmental monitoring and weather forecast will bring enormous social and economic benefits. With the development of manned space technology, the establishment of an industrial production capability in space can become a reality in the not-too-distant future. The realization of production in space will completely change the traditional production processes on earth, and many new industries will emerge.

3. Aerospace Technology Is the Precursor of Modern Science and Technology; It Plays a Leading Role for Technology Advancement and Scientific Development

Aerospace technology makes extensive use of the latest accomplishments of many scientific disciplines; therefore, it is an important indicator of a nation's scientific and technological achievements as well as its industrial capability. The development of aerospace technology relies on the support of many advanced technologies; on the other hand, it also stimulates the development of new technologies such as automatic control, microelectronics, computers, propulsion, guidance and control, precision machinery and material processing. Therefore, aerospace technology is regarded by some as the leader of modern technological revolution. It not only serves as a supplier of advanced technologies for related industries, but also provides a strong driving force for other technological development.

In addition, aerospace technology also provides a strong stimulant for the advancement of science. Scientists generally believe that outer space has been and still is a powerful engine for scientific research. Understanding the structure and evolution of the Universe, the Milky Way, the Solar System and the Earth, including the origin and development of life, has always been an important topic facing mankind. Undoubtedly aerospace technology will provide a powerful tool for the advancement of space science.

II. China's Aerospace Industry Is Facing an Important Decision

China's aerospace industry is currently at a critical juncture in its history. In today's environment of worldwide technological revolution and intense international competition, the future of China's aerospace industry will depend on whether or not we can seize this opportunity and meet the challenges presented to us.

1. Current Status of China's Aerospace Industry

China's aerospace industry was built from a rather primitive industrial background and under very poor economic conditions. Although some technical areas have reached an advanced level, in general the scope and depth of development is still far behind that of developed countries.

The use of rockets as space launch vehicles began in 1957 when the Soviet Union launched the first artificial satellite. Over the past 30 years, more than 150 rockets have been developed by eight countries. At the end of June 1990, a total of 4,048 space launches had taken place, but the number of Chinese launches was only 0.7 percent of the total. China's launch vehicles are limited in number and in versatility; their launch capabilities are far behind those of the United States and the Soviet Union. China's applications satellites are also limited in product types, and their designs need to be improved in the area of durability and reliability. Furthermore, because of lack of coordination, the capabilities of satellites already in service cannot be fully exploited. Expert analysis indicates that China's overall satellite technology is still lagging behind that of developed countries.

Over the past 10 years, in support of the extended use of applications satellites and the increasing level of space-industrial research, the United States, the Soviet Union, France and Japan have been continually increasing research and development funding in aerospace technology. In particular, between 1987 and 2010, the United States may spend as much as $600 billion in space programs.

Thus, China's aerospace industry is driven by domestic demands on the one hand, and challenged by advances in foreign space technologies on the other. For this reason, it is essential that we keep up the momentum of aerospace development in this country.

2. Special Considerations for Establishing Aerospace Policies

Aerospace industry is one of the modern high-technology industries. Because of its strategic implications, its impact on other industries and its inherent risks involved, several complex and difficult factors must be considered when establishing aerospace policies. While aerospace technology can potentially generate large benefits, its development requires huge investments by the state; therefore, a careful cost/benefit analysis should be performed before making such investments. Furthermore, the investments must be made at every stage due to the long development cycle of aerospace technologies.

In China, decisions on aerospace investments are made at the highest level of the government; they reflect the will of the Chinese people and the strategic commitment of the nation; such decisions are guided by the high-priority and long-term interests of the state. Therefore, any policy on the aerospace industry is a strategic policy, not merely a tactical policy; such policy should be established based entirely on economic considerations. Between 1956 and 1987, the Chinese Treasury ran a deficit in 15 of those years; however, investments in aerospace activities continued to increase during this period. In terms of per capita income, aerospace investments reached a peak in the early 1960's. After many years of economic reform and open-door policy, China's economic conditions and the nation's revenue had increased many folds. From this point of view, today's decision environment has improved significantly in comparison with the difficult period of the early 60's and the near-bankrupt era of the 10-year chaos.

3. Major Decisions Facing the Aerospace Industry

China's aerospace industry has always enjoyed high-priority status at the party and state level; it has also received full support at the ministry and local level. Under the leadership of the State Council and the State Planning Commission, the main targets for aerospace development during the "Eighth 5-Year Plan" period and the "Ninth 5-Year Plan" period have been clearly defined, and the primary tasks for the "8-5" period have been assigned. There are three major issues that must be addressed.

(1) Manned Space Technology

Manned space technology is a natural consequence of development of unmanned space technology. Manned space activities will become an increasingly important part of future space activities. China has always been interested in keeping up with the current trend of manned space development around the world. In the "Mid and Long-Term Guidelines for Scientific and Technological Development" established by the state for the period 2000 to 2020, it is clearly stated that sufficient resources must be devoted to manned space research in order to maintain China's position in the international aerospace community.

China already has a good technology base for aerospace development; the state must now decide whether or not

to invest additional resources in manned space technology. Comrade Deng Xiaoping has pointed out on several occasions that the main advantage of the socialist system is that it is capable of focusing its energy on major projects. During the 60's, the state had concentrated its resources in building the bombs and satellite; we believe that in the 90's, China can again focus its energy in carrying out the mission of manned space flight.

(2) Unified Planning of Commercial Aerospace Activities

A strong driving force behind the aerospace industry is the extensive and urgent demands on applications satellites to support economic growth. In this regard, the following issues must be addressed: (a) establishing a unified plan for the development of satellites, launch vehicles and ground systems, and for engineering construction; (b) coordinating the requirements of different organizations and strive for optimum use of the launch vehicle, the satellite and the ground system in order to enhance the overall social and economic benefits; (c) insisting on close cooperation between the development segments, the telemetry and control segments and the operational segments in order to achieve long-term operational stability and to resolve problems in satellite management.

(3) Establishing Policies To Support Aerospace Development

At present, the application of aerospace technology in China is still in its infant stage; potentially many government agencies and ministries can benefit from it. However, the Ministry of Aerospace Industry cannot carry the burden of future development on its own; it must rely on investments provided by the state. Under a tight-budget situation where the state cannot provide direct investments, we suggest that certain policies be established to support aerospace development. For example: (a) policies should be established to induce and promote the use of aerospace technology by different organizations; the cost of construction of ground systems should be borne by the individual organization to ensure adequate funding; (b) trade regulations for the Ministry of Aerospace Industry should be relaxed in order to stimulate autonomous development; (c) fiscal restrictions imposed by the State Treasury on aerospace systems should be reduced to allow the Ministry of Aerospace Industry to raise funds from multiple sources; (d) the Ministry of Aerospace Industry should be given first priority in recruiting top-ranked college graduates; efforts should be made to improve the working conditions and living conditions of ministry employees.

III. Prospects for China's Aerospace Industry in the 90's

We believe that the achievements of China's aerospace industry in the 90's will surpass those of the 80's. A brief description of the activities in this decade is given below.

Efforts will continue in the areas of improving the launch and telemetry/control capabilities of the Long March family of launch vehicles and developing additional applications satellites. Special emphasis will be given to the development of high-capacity communications satellites, weather satellites, multi-functional earth resource satellites, and the corresponding ground systems. In addition, we will also keep up with the latest development in aerospace technology around the world, and strengthen our efforts in basic research. The goal is to achieve major breakthroughs in specific technology areas and to narrow the gap between China and the developed nations.

In order to attain these goals, we must try to improve ourselves not only materialistically but also spiritually; we must also try to cultivate a new generation of highly skilled scientists and engineers. We firmly believe that China's aerospace industry will be able to make significant contributions toward achieving the second strategic targets of modernization and toward shaping the new world order.

Impact of GATT on Nation's Space Industry Analyzed

93FE0852A Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 6, 19 Jun 93 pp 9-10, 12

[Article by Zhao Guanting [6392 0385 1656]: "Impact on Chinese Space Industry of GATT Position"]

[Text] China is soon to return to its position on GATT. The question of what impact this will have on the nation's space industry is one worthy of close attention and study. This article is an attempt to discuss several general viewpoints on this question.

I. Will GATT Have an Impact on China's Space Industry?

GATT will definitely have an impact on China's space industry. This cannot be doubted. This can be appreciated from the course of our country's gradually deepening reforms of its economic system.

Since the 12th Party Congress China has steadfastly maintained a policy of economic liberation. It has put forward a series of policy decisions on reform of the economic system. This has caused the operating mechanisms and management of China's space industry to also give rise to great changes. For example, in product directions, as well as test manufacturing of space products, there has also been the opening up of consumer goods operations. In terms of planning and management, as well as having directive planning, there has also been instructional or guidance planning. In service, at the same time that efforts have been exerted to satisfy the needs of national defense and the national economy, there has also been relatively broad development of launch services directed outside China and export trade. In funding, change from a complete "blank check" or "help yourself" to case-by-case funding and making user departments and test manufacturing departments sign contracts. In organizational management, privileges are gradually put aside in a transition to macromanagement. In distribution, individual income has gone from a

complete reliance on wages to bonuses and supplemental allowances. In unit execution, lucrative contracts are paid and there are project execution cost contracts. In cooperative external relationships, nominally, there is still directive planning. In reality, there are influences from market economics and talk of economic benefits.

GATT is the world's largest international economic organization. Its purpose is the promotion of just and fair free trade in the world and economic growth all over the world. Entering the GATT arena, China can not only enjoy its proper rights but also undertake its corresponding tasks. After China's return to its GATT position, it must abide by the basic principles and regulations of the GATT as well as by a certain number of the GATT's exceptional clauses. This will carry with it a series of impacts on China's economic system and on its system for foreign trade. In terms of the space industry, the impacts will also be inevitable. In terms of the management of space products, even though they have a good number of special characteristics which differ from the general run of other products, for example, the high-level nature of their policy making, the broad nature of their cooperative efforts, the cutting edge of their technology, the complexity of engineering, the concentrated nature of technology, expertise, and capital, the compatibility of military and civilian uses, and so on, it was decided that space products, in terms of management, should reflect the principles of systems engineering, establishing corresponding concentration, direct management, graded responsibilities, and a management system conducive to policy making. However, due to the fact that the test manufacturing of space products is a large-scale, complicated systems engineering undertaking, it is inseparable from national policy making and maintaining the cooperation of the relevant departments, provinces, and cities. Because this is the case, reform of the national economic system is bound to impact the management system of the space industry and the management of foreign cooperation as well as on internal management. The space industry should also organize scientific research and production activities according to the rules for the commercial product economy. This is the general trend of events and is imperative under the circumstances.

II. Beneficial Effects Produced by GATT on China's Space Industry

Upon weighing its pros and cons and conducting a comprehensive analysis, the GATT presents opportunities and challenges to China's space industry. However, summing it up, the advantages outweigh the disadvantages, and it is an extremely rare opportunity. It is only necessary to grasp the chance, ride the tide of deepening reforms, open up markets, and China's space concerns will be capable of achieving development.

1. Advantageous to Formation and Development Associated With Commercialization of the Space Industry

China's space concerns have gone through over 30 years of establishment and development and have achieved great successes which have attracted attention throughout the world. However, speaking in terms of their nature, they still basically belong to the category of products and economy associated with national defense and the work of national economic construction. For the last several years, foreign launch services and product export activities have achieved breakthroughs in development. However, due to the fact that we had not entered into the GATT, we suffered from limitations and restraints in many areas and were not able to equitably participate in competition. For example, we had to launch for foreign countries U.S. test manufactured satellites and were obliged to get U.S. permits. Because of this, there was a series of supplementary conditions which were brought into it. Therefore, this created impacts on contracting for launch missions. After returning to the GATT, our country will be able, according to international standards and conventions, to rely on its own real strength, allowing a fairer participation in the competition of the great world market. At the same time, it will also be possible, according to the requirements of national economic construction, to accelerate the test manufacture of urgently needed practical satellites and new models of carrier rockets, increasing our actual strength, and causing internal and foreign markets to be mutually promoted, mutually interdependent, and mutually coordinated, accelerating the advance of product commercialization.

2. Advantageous to Carrying Out International Space Technology Cooperation

As far as the development of broad technology exchanges and international cooperation is concerned, it is the overall trend in modern science and technology and world economic development with mutual permeation, mutual interdependence, and mutual amalgamation growing deeper by the day. It is difficult to imagine any nation or realm separating from the world economic system and taking up an independent development. Space will be mankind's future inexhaustible treasury of natural resources. The development and utilization of space is the necessary trend in the development of science and technology and is also an area for mutual development of the nations of the world. China should also take a place in it. The broad development of international cooperation is capable of supplying one effective course to choose, and it is also the trend in current world space development. After the disintegration of the Soviet Union, the end of the East-West confrontation and the development and spread of space technology present to mankind the possibility of carrying on cooperation in the realm of space. In the past, there was mutual secrecy between the United States, Europe, and the Soviet Union. Now, in the realm of space, there is the possibility of becoming "partners." Moreover, cooperation has already been developed in several aspects of manned space flight. After our country is in the GATT, there is the possibility of doing away with limitations on our country in several areas, creating the conditions for developing broad international cooperation.

3. Advantageous to Raising High the Starting Point and Foundation for Self-Reliance

On the one hand, China's space industry can make use of the favorable conditions after GATT, directly bringing in even more advanced foreign technology, equipment, device components, and even parts and prototypes. This will result in a reduction in development expenses and a shortening of development periods, raising the basic level of space products and starting point for self-reliance. In another arena, after the GATT, the innate quality and level of the whole of science, technology and industry in China will be raised considerably. With the basic level raised and the level of manufactured space products raised, the level of the space industry built on this foundation must necessarily be raised relatively greatly.

4. Advantageous to the Raising of Management Levels in Fierce International Competition

Today, competition in the world space market is extremely fierce and China's space industry is facing a grim situation. Besides France (Ariane accounts for over 80 percent of the launch market), the United States, Japan, and other such nations, after the disintegration of the Soviet Union, the Russians have already used large capacity launch vehicles to enter the market, even to the point of taking cut-down missiles, adding refits, and launching satellites for foreign countries at extremely low prices.

After the GATT, we will be able to get a firm grasp on the news and situation in world mass production of space products and learn, through negotiations, to win out and protect our basic interests. There is a possibility to borrow from foreign management experiences, refer to international standards, international models, market demands, and standard conventions in managing sales in order to organize scientific research production, service, and sales activities, strengthening competitive consciousness and capabilities, improving management, raising efficiency, and causing our management level to see a relatively great rise, increasing by leaps and bounds.

5. Advantageous to the Expansion of High Technology Consumer Goods Export Trade

After GATT, to put it in a nutshell, the situation for initiating consumer product enterprises is grim. However, comparatively speaking, it is advantageous for high technology consumer goods. After GATT, it is possible to obtain long-term, multilateral most favored nation treatment, and, not only is it possible among the signatory nations, to enjoy the advantages of GATT, but it is also possible, toward the relevant signatory parties, to put forward our requirement to let down tariffs on our country's great export interest—its high technology products. This is advantageous for the expansion of export trade in high technology consumer goods. Space technology is our country's high technology business and has the advantage of initiating high technology consumer goods. GATT will make us bring into full play our superiorities, adopt measures, concentrate strengths, initiate high technology consumer goods, and, in conjunction with this, gradually realize collectivization, industrialization, internationalization, the creation of a diversified, multilateral arrangement for export trade.

6. It Is Possible To Make Use of Certain Exceptional Provisions of the GATT To Carry Out Rational Protection

Although the GATT, together with the World Bank and the International Monetary Organization, are called the three great pillars readjusting world economic and trade relationships, in and of itself, it is, however, only a quasi-international organization. This agreement, in reality, is a product of negotiation and consultation between the parties signing the treaty. As a result of this, these treaties are flexible, balancing the rights and responsibilities of the various parties. Because this is the case, in order to raise competitive capabilities, the nation is capable, beginning with its interests as a whole, of opting for various types of effective measures, concentrating the power of the whole nation's people, to support this high technology space industry, which is rare and hard to come by. When necessary, it is also possible to make use of three provisions in the GATT, that is, the "Provision for Protecting Infant Industries," the "Provision for Protecting International Balance of Payments," and the "Guarantee Provision," to carry out rational protection, promote advantages and avoid damage, and very firmly grasp the right of autonomous action.

III. The Quickening Pace of Reform Welcomes the GATT Challenge

Based on the actual situation and special characteristics of our nation's space industry, in order to meet the GATT challenge, we should select effective measures and quicken the pace of reforms.

1. Develop High Technology and Promote the Industrialization of the Results

As far as turning of the achievements of the accelerating high science and technology of space toward actual production capability is concerned, it is most basically that we should give full rein to market economic mechanisms, adopt political policies, and stimulate technology transfer. In the exploitation of products, not only are the execution of scientific research, planning, intermediate testing, and the integration of production necessary to putting out products; moreover, one must decide technology questions relating to production, arrive at a transition to commercial products and a level of practical usefulness. As far as strengthening the exchange of the achievements of space science and technology and work to spread their application is concerned, we must set up proper organizations for their propagation. We must create high technology medium and small-scale enterprises or set up joint management with medium and small-scale enterprises, making the achievements of science and technology to be rapidly transformed into productive power.

2. Giving Full Rein to the Superiorities of Collective Bodies and the Setting Up of Large-Scale Enterprise Groups

In order to adapt to the needs of market economics, it is necessary to set up enterprise groups possessing competitive

capabilities inside and outside China, to carry forward the scaling of management, and the gradual realization of the formation of groups, industrialization, and internationalization. In order to occupy an even larger share in the world space market, besides exhaustively striving to obtain maximum support from the nation, under conditions in which it is possible, through a variety of forms such as the buying of shares in products or technologies, we must draw in foreign capital, even to the point of carrying out experiments with the stock system, so as to obtain support in various areas inside and outside China and establish groups of companies across industries, across regions, and across nations.

3. Strengthening Scientific Management and Nurturing Technical Talent

It is necessary to raise the market consciousness, trade consciousness, and capacity for adaptation in the space rank and file to form a body of talented people in law, business, and management who understand science and technology, can run businesses, improve management, understand the international market, and be thoroughly familiar with international laws and conventions.

4. Strengthen Protective Consciousness Toward High Technology Intellectual Property Rights

To adapt to the GATT and trends toward the internationalized running of high technology industries, it is necessary to strengthen the consciousness of intellectual property rights in such things as protective patents, products, trademarks, and so on, to learn to operate intellectual property rights laws and regulations as well as international conventions in order to protect the legal rights associated with high technology products. In opening up the international marketplace, it is particularly necessary to be skilled in the selection and utilization of patents, trademarks, and products. We must be thoroughly familiar with and firmly grasp the latest developments in patent law, trademark law, and international conventions to effectively protect our own patents, trademarks, and products.

Large Wind Tunnel Facilities Can Handle Aircraft, Missiles, and Launch Vehicles

93fe0956a Chengdu SICHUAN RIBAO in Chinese 14 Aug 93 p 1

[Article by Yu Zhengdao [0151 2973 6670]]

[Text] The Aerodynamics Research Center of the Commission of Science, Technology and Industry for National Defense is charged with the responsibility of conducting aerodynamics research for China's flight vehicles. Through technical improvements of test facilities and research of test procedures, it has constructed a number of high-tech wind tunnel test facilities which are designed to satisfy the needs of developing new flight vehicles in the 90s.

Wind tunnel testing is an important means for designing the aerodynamic configurations of flight vehicles such as aircraft, missiles and launch vehicles. Advanced wind tunnel facilities are essential for developing advanced flight vehicles. In order to satisfy China's needs of developing future flight vehicles, the Research Center has devoted a significant part of its resources in recent years to improve the test capability of existing wind tunnels. Between 1983 and 1992, the Center invested more than 30 million yuan to implement 59 technical improvements at some of its key wind tunnel facilities. These improvements raised the standard of China's wind tunnels to the world standard of the late 1980s; they have received over 20 Ministry-level awards for scientific and technological achievements. Specifically, with improvements made to the 4m x 3m low-speed wind tunnel, its performance, versatility and degree of automation are among the best of China's low-speed tunnels; its technical standard is comparable to similar wind tunnels built in Western Europe. Over the past 5 years, this Center has also completed more than 100 research projects studying different test methods and procedures in support of new vehicle development; more than 40 of the projects have received achievement awards.

Today, the Center has the largest and most powerful wind tunnel facilities in Asia; these facilities have the capability to perform both conventional and special tests. They also rank first in Asia in terms of the ability to accommodate different test models, to produce high-precision data and to provide accurate measurements. With these new facilities, we are no longer constrained by the situation of the past where many important wind-tunnel tests either had to be abandoned or be conducted by foreign organizations at great expense.

One of the most advanced and most difficult techniques in wind-tunnel testing is the "appendage controlled trajectory technique." After 10 years of research, the Center has mastered the technique and has applied it to the measurement of separation trajectory of appended missiles as part of China's bomber development program. Since 1985, the Center has conducted 107,000 tests, which is equal to the total number of tests over the previous 15 years. They have received 430 achievement awards at various levels.

Xiamen Space Monitoring Station Completed

93fe0956b Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 18 Jun 93 p 1

[Text] Xiamen, 17 May—Construction of China's new space monitoring station in Xiamen was completed today. It was given the official name "Xian Satellite Monitoring Center, Xiamen Monitoring Station" by the chairman of the Commission of Science, Technology and Industry for National Defense.

This is a modern, integrated station with full monitoring capability. It can perform tracking and control functions not only for low-altitude and medium-altitude satellites, but also for sun-synchronous and geosynchronous satellites. It can also provide monitoring support for such activities as satellite on-orbit management and launch of commercial satellites.

The installation of a permanent monitoring station along the southeast coast of China eliminates the need for deploying mobile monitoring stations during each space

launch; it also extends the monitoring time over China's landmass and adds an important node to the Xian-based space monitoring network.

Guizhou Aviation Group Expands Diversified Interests

93FE0911A Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 7, Jul 93 pp 23-25

[Article by Yen Guorong [6768 0948 2837]]

[Text] This article about the Guizhou Aviation Industrial Group (GAIG) was written by reporters of INTERNATIONAL AVIATION after an extensive interview conducted at Anshun, Guizhou Province.

The Guizhou Aviation Industry was established in the mid-1960's; it was organized based on the unique concept of a modular system structure. Today, it has become one of the highly specialized large enterprises of China's aviation industry; it has the manufacturing capability to build 80 percent of its airplanes and aircraft engines. Its organization has four major divisions: aircraft design and manufacturing, aircraft engine design and manufacturing, development and production of onboard equipment and special products.

Guided by the policy established by the 11th Party Congress to convert military production to commercial production, efforts were initiated at the end of 1985 to transform the Guizhou Aviation Industry into a modern research and production facility with aircraft and automobiles as its main product lines. In May 1992, the Guizhou Aviation Industry Group (GAIG) was formed, with the Guizhou Aviation Industrial Corporation (GAIC) as its nucleus; it was one of the 55 state-approved trial enterprise groups. GAIG has become a large trans-regional, trans-industrial and trans-departmental enterprise group, engaging in research, development and manufacturing of fighter-trainers (including aircraft engines), and mini-sedans (including mini-engines).

The GAIC currently has more than 70,000 employees, including 22,000 technicians, more than 1,500 senior engineers and approximately 8,000 mid-level engineers. Its total production has increased from 300 million yuan (prior to economic reform) to more than 1.4 billion yuan; its profit has increased from several million yuan to over 100 million yuan. In 1991, GAIG's industrial production was one-seventh the total output of China's aviation industry; its profit was approximately one-fourth of the total profit. The total production is expected to reach 2.3-2.5 billion yuan by 1995.

Improvement and Modification of Aviation Products

Serialization of the FT-7 Aircraft

The GAIG has the capability to design and build airplanes as well as aircraft engines and certain onboard equipment. Since its establishment, the GAIC has developed eight different models of airplanes. To meet the domestic needs for training new pilots, it has developed the FT-7 (domestic model number J7L) training aircraft, whose design was certified in 1987. Subsequently, the FT-7B fighter training aircraft was developed to meet the needs of foreign clients; it has six different models designed to satisfy the requirements of different user nations.

In 1988, efforts were initiated in response to requests by foreign customers to develop the FT-7P aircraft. Preliminary design of the FT-7P began in March 1989 and its virgin flight took place in October 1990; in May 1992 design certification was completed.

The model P aircraft was developed from the FT-7B by incorporating significant modifications to the design; these modifications include: adding an extra pair of wing attachments; extending the cruising time of the airplane; improving the weapon system, the fire control system, the ventilation system and the navigation system; installing an electronic countermeasure system; improving the instrument-panel layout; and improving the maintainability of the aircraft. These improvements greatly enhance the performance of the FT-7P both as a training aircraft and as a combat aircraft. Ordinarily, modifications of such magnitude require a development cycle of 3-5 years; however, at the request of the clients, GAIG was faced with the challenge of completing the task within 2 years. In the end, not only was the FT-7P successfully developed within the specified period (19 months), it received high praise from the users because of its high-quality workmanship, good controllability and low maintenance requirement. Development of the FT-7P not only generated significant revenue for the state in foreign trade, it also laid a solid technical foundation for future development of the FT-7 aircraft and for achieving the goal of serialization.

In order to satisfy new requirements and to correct some of the operational problems of the original FT-7 aircraft, the GAIG is considering further improvements for the FT-7.

Serialization of the Turbojet-7 and Turbojet-13 Engines

The design and manufacturing of aircraft engines is the responsibility of Li Yang Machinery Co. of the GAIG. The company was established in 1981, and consists of three main factories, a research division and a materials warehouse; it has 13,000 employees.

The main products of Li Yang Co. include the Turbojet-7 and Turbojet-13 engines, which are used as the primary power plants on domestic fighter aircraft. They are also the company's main product line for export; up to now, over 1,000 engines have been sold to foreign customers. The total number of engines produced by Li Yang Co. accounts for more than half the total output of China's aircraft engine manufacturers.

The Turbojet-7 and Turbojet-13 engines are under continuous development and modification to improve their performance.

Diversification of Commercial Products

In addition to airplanes, aircraft engines and onboard equipment, the GAIG has also developed a number of commercial products: automobiles (mini-sedans, passenger coaches, garbage trucks, etc.), automobile parts, tobacco

packaging machines, hydraulic components, food-processing machines and tools. These products are considered the best among domestic products and are also well received on the international market. GAIG's commercial products now account for more than half of its total output.

During the interview, the reporters have visited the following commercial product companies:

—Shuang Yang Airplane Factory. Its main commercial product is the "Yun Que" sedan, whose production is under the direct management of GAIC. This automobile was developed using imported technology from the Fuji Heavy Industry Group of Japan; it has attractive styling, logical structural layout, good reliability and durability, low cost and good fuel economy. It represents a state-of-the-art design of mini-sedans of the 1980's. This automobile is currently being produced on a small scale and a large-scale production line is under construction. According to a company spokesman, sale of this automobile on the domestic market appears quite promising. On 9 April, GAIC signed a preliminary contract with the Gold Key Industrial Group of Hong Kong to jointly produce the "Yun Que" sedan.

—Yun Ma Airplane Factory. Drawing from its technical expertise in manufacturing and assembling airplane parts, this factory is devoting considerable resources in developing an automobile line as its main commercial product. Last year the ratio between its commercial products and military products was 61:49; this year the ratio will rise to 80:20. The main automobile product is the "Yun Ma" passenger coach, which is being produced at the rate of 1,000 per year. In order to accommodate the demands of the high-end passenger car market, the factory is planning to invest 20 million yuan in technical improvements to change the "Yun Ma" passenger coach to a luxury automobile.

—Hong Yang Machine Factory. The Hong Yang Factory is a specialized facility for manufacturing rubber and plastic seals with more than 1,000 employees. Before 1987 it was primarily a military production facility with a total output of around 5 million yuan. In the early 1980's, the factory foresaw the growth of China's automobile industry and the expanding market of sealing strips for automobile doors and windows; consequently it decided to import the ST-90 series sealing-strip production line from Japan. From 1988 to 1992, the total factory output grew at an astonishing rate of 10 million yuan per year. In 1992, the total revenue reached 96.81 million yuan, and profit was 15.13 million yuan (2.1 times the 1991 profit). Its tax liability was 4.43 million yuan, and the per capita profit was 16,330 yuan, which ranked first among all enterprises of the GAIG. The production target for 1993 is 150 million yuan.

The Hong Yang Machine Factory produces more than 200 different types of sealing strips for automobile doors and windows. Its output accounts for more than half the total production of sealing strips in this country;' it has become one of 12 "mini giant" enterprises of automobile parts manufacturers. Over the next few years, the factory is planning to develop into a high-efficiency, integrated enterprise; by 1995, the total output is expected to approach 1 billion yuan.

—Ping Shui Machine Factory. Its key product is tobacco machinery; currently it produces the model 6000 cigarette packaging machine. Since last year, it began developing the model 8000 packaging unit by importing state-of-the-art technology from the GD Co. of Italy. Customers of the Ping Shui Factory are quite satisfied with its tobacco machines and its after-sale service. In 1991 the factory made a profit of 15.8 million yuan, and its per capita profit ranked first among all the enterprises of GAIC. Last year, the total revenue was 85.99 million yuan, and profit was 13.0 million yuan; its per capita profit ranked second among the enterprises of GAIC.

—Huan Yu Machine Factory. Before 1984, this factory had been engaged in the production of guided missiles; since 1984, missile production came to a complete halt, and the factory ran into serious financial difficulty. With the support from the Ministry of Aviation and Aerospace Industry, the Provincial Government of Guizhou and the GAIC, the Huan Yu Factory has developed several commercial products including cigarette packaging machines and engines for the "Yun Que" automobile. Construction of the production line for the "Yun Que" engine has been completed. Last year, 100 engine units were produced, and this year the number is expected to reach 1,200; the target is 180,000 units per year. Although the profit level of the factory is still relatively flat, its employees are enthusiastic about their work and have high confidence in the factory's products.

Post-Interview Comments

During the 5-day interview, we have visited 10 different factories of the GAIG and met many officers and employees in the Guizhou region who had devoted their careers to national defense. We were deeply moved by their selfless attitudes and their enthusiastic spirit.

In a conversation with GAIC's chief engineer, Gao Qinhuai, he said the development of the FT-7P aircraft not only presented an opportunity to build a strong technical team, but also united all the scientists and engineers to accept tough challenges to meet a common goal. Completing a project of such magnitude within a period of 19 months was truly a rare accomplishment in this country.

Study of Physico-Chemical Process in Laser Synthesis of Ultrafine SiC Powder

93FE0877A Beijing GUISUANYAN XUEBAO [JOURNAL OF THE CHINESE CERAMICS SOCIETY] in Chinese Vol 21 No 1, Feb 93; No 2, Apr 93

[Article by Sui Tongbo [7131 0681 3134], correspondent, and Wang Tingji [3769 1694 4694] of the Chinese Institute of Building Materials Science, Beijing 100024: "Study of Physico-Chemical Process in Laser Synthesis of Ultrafine SiC Powder"; MS received 24 May 91]

[Vol 21 No 1, Feb 93 pp 33-37]

[Text] **Part I. Experimental Laws, Powder Characteristics**

Abstract: A 50 W continuous-wave CO_2 laser was used as a heat source to induce the chemical reaction between SiH_4 and C_2H_4 for synthesizing ultrafine SiC powder. Experiments determine the parameters such as pressure p in the reaction chamber, atomic ratio C/Si in the gas, nozzle diameter 2r, and the relationship between laser power density and powder characteristics, as well as the physical and chemical properties of the synthesized product.

Key Words: laser, gas-phase chemical reaction, silicon carbide, ultrafine powder.

1. Introduction

Manufacturing powder by laser synthesis is one of the most competitive methods among powder production techniques. The synthesized powder meets all the ideal requirements as suggested by Bowen,[1] i.e., small particle size, narrow particle size distribution range, no agglomeration, spherical configuration, and high purity. The laser method of producing high-purity ultrafine powder was initiated by MIT.[2] Similar research has also been launched in Japan, France, and other countries.[3,4]

This experiment studies the rules and mechanism of synthesizing ultrafine SiC powder from the $SiH_4 + C_2H_4$ system with a 50 W continuous-wave (CW) CO_2 laser (wavelength 10.6 μm) as the heating source.

2. Experimental Work and Results

2.1 Experimental Process

The synthesis of ultrafine SiC powder is based on a gas-phase chemical reaction as follows:

$$SiH_4(g) + (1/2)C_2H_4(g) = SiC(s) + 3H_2(g).$$

Figure 1 shows the schematic diagram of the device arrangement for this experiment. Its main feature is that the flow directions of the mixed reacting gas are perpendicular to the laser beam. A mechanical vacuum pump evacuates the reaction chamber and the tubing system to an atmospheric pressure of about 1.33 Pa. The buffer gas Ar flows into the chamber window as well as into the nozzle through the respective mass flow controllers

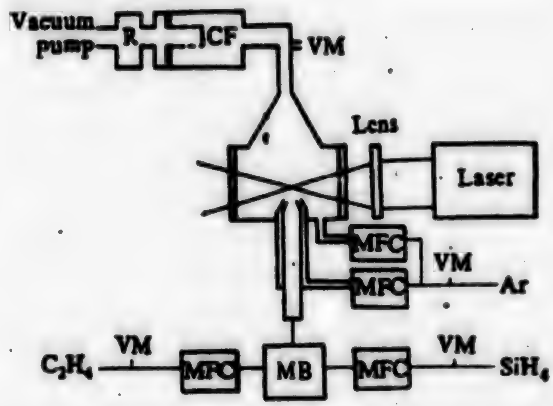

Figure 1. Schematic Drawing of Device for Laser Synthesis of Ultrafine SiC Powder

(MFC). Reaction gases, SiH_4 and C_2H_4, through their respective MFCs, flow into the mixing box (MB), and then the gas mixture enters the nozzle. The regulator (R) adjusts the pressure in the reaction chamber. The laser output power is 35-40 W. After the laser beam is focused with a KCl crystal lens, its power density reaches 860-1,000 W/cm^2. When the gas mixture of SiH_4 and C_2H_4 meets the focused laser beam, it quickly reaches the reaction temperature through its resonance with laser energy and the collision of atoms. The powder produced by the reaction is carried with Ar gas into the collector (CF). The reaction consumes about 10 percent of the laser energy and produces ultrafine SiC powder at a rate of 0.6 gram per hour.

2.2 Experiment on Reaction Conditions

2.2.1 Effect of the C/Si Atomic Ratio on the Gas Mixture

The inside diameter of the fixed nozzle is 2r = 1.0 mm. The pressure in the reaction chamber is p = 0.08 MPa. The fraction of free silicon (f-Si) in the product decreases with the increase of C/Si atomic ratio, as shown in Figure 2.

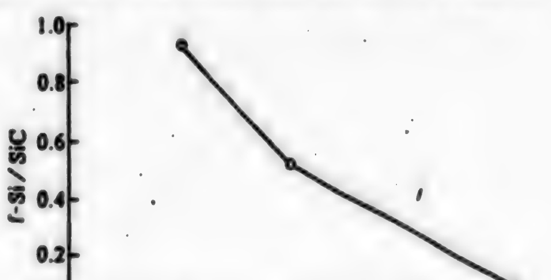

Figure 2. Effect of C/Si Atomic Ratio in Gas Mixture on f-Si Content in Laser Powder

2.2.2 Effect of Pressure p in Reaction Chamber

When all other conditions remain unchanged, the weight percent w of free silicon in the product decreases with reaction chamber pressure p, as shown in Figure 3.

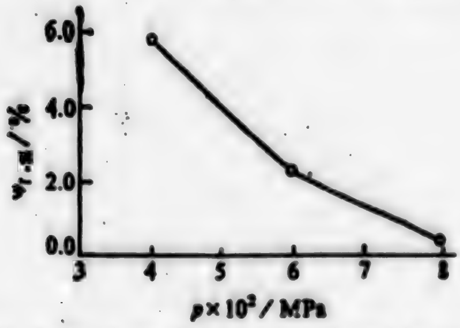

Figure 3. Effect of Cell Pressure p on f-Si Content in Laser Powder

2.2.3 Effect of the Nozzle's Inside Diameter 2r

2.2.3.1 2r = 0.50 mm: At a chamber pressure of $p \leq 0.10$ MPa, even when the flow ratio C_2H_4/SiH_4 is as high as 40/5, f-Si still exists in the product. The flow unit for both C_2H_4 and SiH_4 is mL/min.

2.2.3.2 2r = 1.0 mm: The f-Si can be practically eliminated under the conditions of $p \geq 0.08$ MPa and flow ratio $C_2H_4/SiH_4 \geq 40/4$; or $p \geq 0.10$ MPa and $C_2H_4/SiH_4 \geq 30/5$.

2.2.3.3 2r = 2.0 mm: The f-Si can be practically eliminated under the conditions of $p \geq 0.08$ MPa and $C_2H_4/SiH_4 \geq 20/10$; or $p \geq 0.04$ MPa and $C_2H_4/SiH_4 \geq 40/5$.

These results are consolidated in Figure 4, in which the shaded area represents the conditions under which f-Si will not exist in the product.

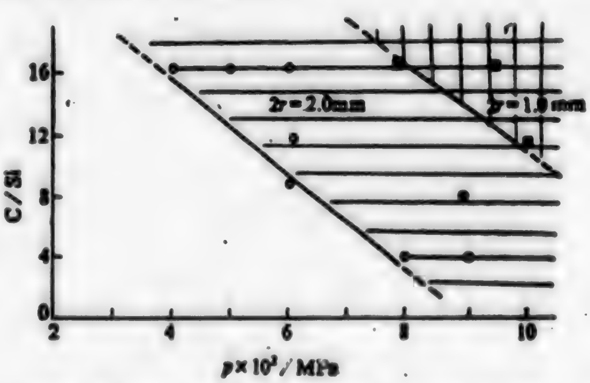

Figure 4. Experimental Conditions in Laser Synthesis of Ultrafine SiC Powder Without f-Si, Indicated by the Shaded Area

2.2.4 Effect of Focal Length of Lens

When the focal length of the lens is 50 mm or 100 mm, the reaction zone is small, resulting in low production rate, but the SiC powder tends to be crystalline because of the high laser power density and the high reaction temperature. When the focal length is 140 mm, the reaction zone is large, resulting in higher production, but the SiC powder is practically non-crystalline.

2.2.5 Effect of Ar

Argon flows into the system at two different locations: the nozzle and the chamber window. It serves two functions: as carrier gas and as protection gas. When the Ar flow rate into the nozzle is less than 0.40 L/min, the reaction zone is not stable and tends to disperse. When the Ar flow rate is 0.40 L/min or higher, the reaction is comparatively stable and tends to concentrate in a small zone. To obtain a stable flow into the chamber, the Ar flow rates in both paths are selected to be 0.40 L/min. In the experiment, Ar does not show other effects.

2.3 Powder Characteristics

The physical and chemical characteristics of the powder have been tested and analyzed with X-ray diffraction, electron diffraction, infrared absorption spectroscopy, transmission electron microscopy (TEM), emission spectroscopy, and chemical analysis. Table 1 shows the characteristics of the ultrafine SiC powder made under two typical sets of experimental conditions. Figure 5 [photographs not reproduced] shows the TEM photographs of the ultrafine SiC powder made under the two different conditions (a,b), respectively.

Table 1. Typical Experimental Conditions and Characteristics of SiC Powder Produced by Laser Synthesis Process

Laser power density/W·cm^{-2}		860-1000	
Lens focus/mm		140	
Nozzle inner diameter/mm	1.0		2.0
Cell pressure/MPa	0.08		0.08
Argon flow rate/L·min^{-1}	0.80		0.80
C_2H_4 flow rate/mL·min^{-1}	40		20
SiH_4 flow rate/mL·min^{-1}	5		10
Ultrafine SiC powder	(a)		(b)
Powder size/nm	10-18		20-35
Specific area/m^2·g^{-1}	98.5		76.5
Crystallinity	Some		No
SiC mass content/%		>96.0	
O_2 mass content/%		<2.34	
Metal content/10^{-6}		<10	

2.3.1 Physical Properties

Table 1 and Figure 5 show that the ultrafine SiC powder made by laser synthesis has high purity and is loosely agglomerated. Its grains are ultrafine (nanoscale), spherical, with narrow size distribution. The powder meets the ideal powder requirements. When the powder contains f-Si, it looks brownish; when it contains free carbon (f-C), it looks blackish. Grayish color indicates that the stoichiometric ratio of SiC is correct.

2.3.2 Chemical Properties

Chemical analysis shows that the synthesized product contains about 96.0 weight percent of SiC and very low metallic impurities. The main impurity in the powder is oxygen, which is adsorbed onto the highly active powder in the atmosphere. A small amount of oxygen enters the chamber along with Ar as well as with the reaction gases, and it forms oxide (combined oxygen) with the substances in the chamber. The oxygen content can be maintained at below 1.0 weight percent, if the powder is collected and stored in isolation from the atmosphere.

Figure 6 shows the infrared absorption spectrum of the powder. The strongest absorption peak indicates the Si-C bond.

2.3.3 Powder Crystalline State

The X-ray diffraction and electron diffraction analyses show that the product is mainly non-crystalline SiC with a small amount of β-SiC as shown in Figure 7.

3. Conclusions

(1) The ultra SiC powder made with a laser synthesis method meets the ideal powder specifications.

(2) The increase of the flow ratio C_2H_4/SiH_4, the pressure inside the reaction chamber, the nozzle inside diameter, and the laser power intensity reduce f-Si in the product. In other words, the product is closer to the SiC stoichiometric ratio.

(3) As shown in Figure 4, the conditions for the synthesizing of high-quality ultrafine SiC powder are not restricted to one point, but spread in a defined area.

(4) The SiC content in the product is above 96.0 weight percent.

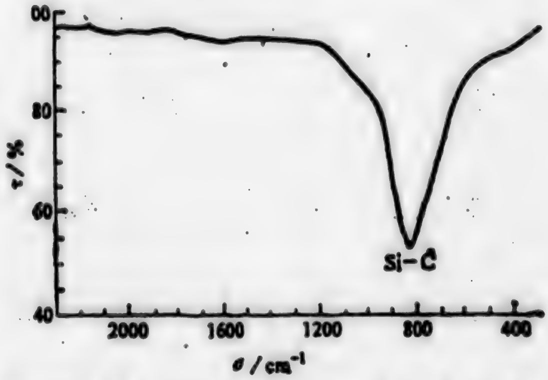

Figure 6. IR Absorption Spectrum of SiC Powder in KBr Pellets

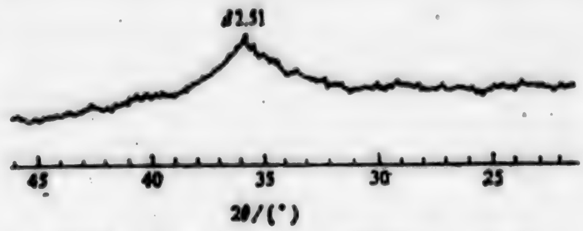

Figure 7. XRD Pattern of Ultrafine SiC Powder

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[Vol 21 No 2, Apr 93 pp 163-168]

[Excerpts] **Part II. Modeling, Analysis**

Abstract: Based on experimental results in Part I of this paper, and the law of conservation of energy, a simplified theoretical model is proposed. From the model, the relation between reaction temperature T and other technical parameters is derived as follows: $T = T_0 + (X/Y)[1 - \exp(-Y\tau/b)]$. Results calculated from this equation agree with the experimental results. The reaction feasibility and the production rate of ultrafine SiC powder are investigated according to the thermodynamic theories.

[Introduction]

The complexity of the entire chemical and physical process makes it difficult to describe the gas-phase chemical reaction induced by the laser. Haggerty et al.[1-3] did extensive work in this field. To further study the inherent rules of laser-produced power, this paper proposes a simplified theoretical model based on the experimental data. The model establishes a series of conclusions which agree with the experimental results. Based on thermodynamic theories and the simplified theoretical model, this paper analyzes and estimates the reaction feasibility and the powder production rate of the

laser process. The experimental parameters and powder characteristics are stated in Part I[4] of this paper.

1. Model and Analysis

1.1 Simplified Theoretical Model

Let us assume that after absorbing the laser energy, the material in the reaction zone maintains a thermal equilibrium state, then the total laser energy dE absorbed by the material is partially (dE') used for producing SiC; and the balance of the absorbed energy dE" is consumed by heat exchange with surrounding substances. The relation can be expressed in the following equation:

$$dE = dE' + dE'' \qquad (1)$$

After absorbing the laser energy, the reaction gases rapidly raise its temperature from the environmental temperature T_0 to the reaction temperature T. Through a series of calculations[5] from Equation (1), we can derive the relation between T and other parameters, namely, laser power output P, nozzle inside radius r, the length l of the laser heating zone, and the pressure p inside the reaction chamber. The derived equation is listed as follows:

$$T = T_0 + (X/Y)[1 - \exp(-Y\tau/b)] \qquad (2)$$

where:

X and Y are constants in the process parameters;

$X = [a_c\,(C/Si) + a_s\,P;$

$Y = c\,(Ar/Si);$

τ is length of time the gases stay in the reaction zone and is given by $\tau = (\pi r^2/V)\,(p/p')\,l$;

a_c and a_s are the absorption constants at 10.6-μm wavelength for C_2H_4 and SiH_4, respectively;

C/Si and Ar/Si are the atomic ratios in the gas source, respectively;

p' is gas pressure in the tubing system;

V is total flow of C_2H_4 and SiH_4 in the gas source; and

b and c are ratio constants.

Equation (2) explains the test results of Part I of this paper quite satisfactorily under the assumption that the reaction product SiC depends on reaction temperature T, i.e., the higher the T, the more SiC product and the less free silicon (f-Si).

Figure 1 and Figure 2 display the theoretical curves plotted from Equation (2), where: $a_c = 0.1$, $a_s = 0.5$, $b = 0.1$, $c = 0.5$, $p' = 0.14$ MPa, $l = 0.20$ cm, and $P = 40$ W.

Figure 1 shows the relation between reaction temperature T and C/Si ratio in the gas source, inside nozzle diameter 2r, SiH_4 flow rate, and the chamber inside pressure p, when Ar/Si is fixed at 80.

Figure 1 also shows that reaction temperature T increases with increase in reaction chamber pressure, C/Si ratio in the gas source, and the inside diameter of the nozzle. This indicates that for the same reaction, a small-diameter nozzle requires higher gas pressure, and lower gas pressure will suffice for a larger-diameter nozzle. In other words, high reaction gas pressure for a large-diameter nozzle can effectively increase the reaction temperature and eliminate f-Si. The conclusion agrees with the experimental results in Part I of this paper.

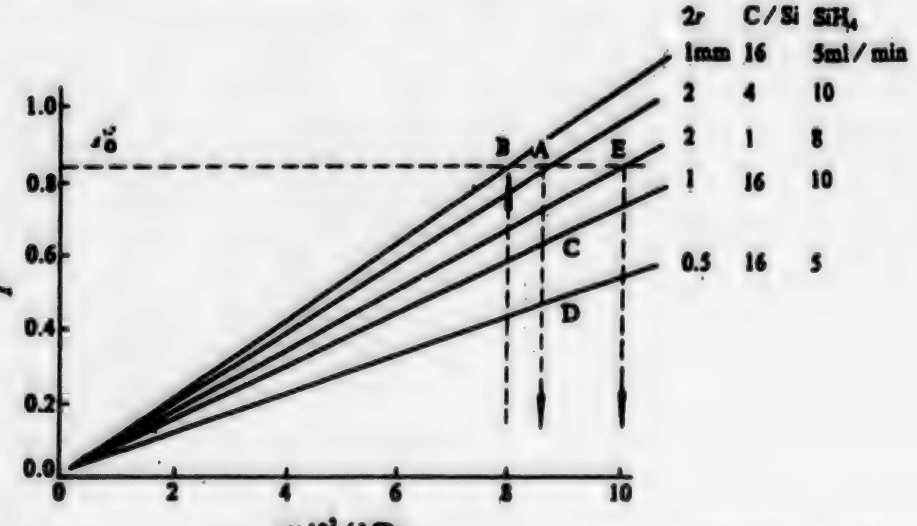

Figure 1. Theoretical Dependence of Reaction Temperature Upon Inner Diameter of the Nozzle 2r, C/Si Atomic Ratio in Gas Mixture, SiH_4 Flow Rate and Cell Pressure; T is a Normalized Temperature

Interestingly, the experiment has determined that f-Si can be eliminated under condition B ($2r = 1.0$ mm, $SiH_4 = 5$ ml/min, $p = 0.08$ MPa, and $C/Si = 16$). From Figure 1, reaction temperature T'_0 under this condition can be reached. Based on this finding, other conditions (A, C, D, and E) to achieve the same purpose can also be deduced as follows:

Condition A. $2r = 2.0$ mm, $SiH_4 = 10$ ml/min, $p = 0.085$ MPa, and $C/Si = 4$;

Condition C. $2r = 1.0$ mm, $SiH_4 = 10$ ml/min, $p > 0.1$ MPa, and $C/Si = 16$;

Condition D. $2r = 0.5$ mm, $SiH_4 = 5$ ml/min, $p > 0.1$ MPa, and $C/Si = 16$.

All the above agrees with the experimental results in Part I of this paper, and explains that the existence of f-Si is mainly caused by a temperature below the required reaction temperature.

It is worth mentioning that condition E ($2r = 2.0$ mm, $SiH_4 = 8$ ml/min, $p = 0.1$ MPa, and $C/Si = 1$) where $C/Si = 1$, is derived from condition B, which indicates that it is possible to use a low-power laser to produce ultrafine SiC powder conforming to the stoichiometric ratio. Experiments to prove the theory are in progress.

Figure 2 shows the relation between reaction temperature and atomic ratio Ar/Si in the gas source. Reaction temperatures rapidly decline with increase in Ar/Si ratio until Ar/Si reaches 60. From then on, changes of Ar/Si ratio are not apparent. The experiment in Part I used this Ar/Si value, which explains why the Ar content did not affect the experimental results. [Passage omitted]

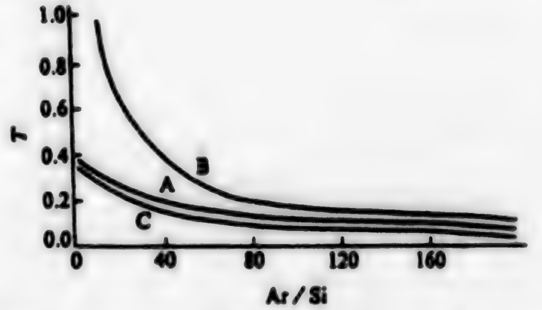

Figure 2. Theoretical Dependence of Reaction Temperature T Upon Ar/Si Atomic Ratio in Gas Mixture; T is a Normalized Temperature

2. Conclusions

(1) The fact that the simplified theoretical model and a series of deduced conclusions agree with the experiment as described in Part I indicates that to a certain degree they reflect the inherent rules of powder production by laser.

(2) The temperature equation (2) and production rate formulae (9-1 and 9-2) point out the direction of parameter adjustment as well as the target production rate.

(3) The conditions deduced from theoretical chemical reactions are considered the most scientific and economical working conditions. In theory, working under the conditions of theoretical reaction, it is possible to produce SiC with stoichiometric ratio through the use of low-power laser devices.

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Study of TiB_2-Ti(C,N) Ceramic Composites Prepared by Reactive Hot-Pressing

93FE0877B Beijing GUISUANYAN XUEBAO [JOURNAL OF THE CHINESE CERAMICS SOCIETY] in Chinese Vol 21 No 2, Apr 93 pp 182-187

[Article by Zhang Guojun [1728 0948 6511], correspondent, the Institute of Advanced Ceramic Technology, Chinese Academy of Building Materials Science, Beijing 100024: "Study of TiB_2-Ti(C,N) Multiphase Ceramics Prepared by Reactive Hot-Pressing"; MS received 21 Dec 91]

[Text] **Abstract:** Through chemical reaction design, TiB_2-Ti(C,N) ceramic composites (multi-phase ceramics) can be manufactured by the reactive hot-pressing method with Ti, TiH_2, BN, B_4C, C, B, etc., as raw materials. The method is simple and its manufacturing cost is low. SEM

shows that in the composites, ultrafine (about a few tens of nanometers) Ti(C,N) and TiB_2 crystals are distributed in the TiB_2 and $TiC_{0.5}N_{0.5}$ grains, respectively. This type of structure can possibly affect the material properties greatly. It deserves further research on the means to control this type of structure. Fracture surface analysis shows that transgranular fractures occur on the coarser TiB_2 crystals.

Key Words: Titanium diboride, titanium carbonitride, reactive hot pressing, microstructure, ceramic nanocomposite, reaction mechanism.

1. Introduction

The high melting point and hardness as well as the good chemical stability of the TiB_2 and Ti(C,N) compounds makes them good candidate materials for cutting tools and machine parts requiring good abrasive resistance. They also have good electrical conductivity which makes them candidates for electrodes.

As cutting-tool materials, TiB_2 has a higher hardness than Ti(C,N), while the nitrogen content in the latter can greatly decrease the friction coefficient during steel cutting. Both merits benefit the cutting process. Hence, ceramic composites made from TiB_2 and Ti(C,N) will have high hardness and low friction coefficient. Tadahiko Watanabe et al. conducted research on this material for many years with good results,[1-3] and believed the composite to be promising cutting-tool material. They used a two-step manufacturing process. First, TiB_2 and Ti(C,N) were synthesized separately, and then mixed together with other ingredients. The mixture was either hot-pressed[1,3] or sintered[2] to TiB_2-Ti(C,N) ceramic composite. The press-sintering method simplified the production technique and reduced the cost.[2] Currently, the bend strength of the composite made by the press-sintering method is 600 MPa, but the composite made by the hot-press method can reach 900 MPa. This investigation adopts a single-step process, i.e., reactive hot-pressing,[4] which mainly uses the following chemical reactions:

$$TiH_2 \longrightarrow Ti + H_2\uparrow$$

$$(1+\alpha)Ti + (1-x)BN + \frac{2\alpha+x-1}{4}B_4C + \frac{3x-2\alpha+1}{4}C \longrightarrow \alpha TiB_2 + TiC_xN_{1-x} \quad (1)$$

$$(1+\beta)Ti + (1-x)BN + xB_4C + (2\beta-3x-1)B \longrightarrow \beta TiB_2 + TiC_xN_{1-x} \quad (2)$$

where: x = 0-1, α = 0-2, and β ≥ 2. This process eliminates the synthesizing of raw materials, simplifies the manufacturing method, and thus greatly reduces the production cost. This paper presents the reaction mechanism during the course of reactive hot-pressing, the mechanism of the microstructure formation, and other related phenomena.

2. Experimental Work and Results

2.1 Sample Preparation

The experiment adopted reaction (1) with x = 0.5 and α = 1.25. The starting materials were: TiH_2 (made by the Beijing Nonferrous Metals Research Institute), BN (made by Yingkou Fine Chemicals Plant), and B_4C (made by Mudanjiang Second Grinding Materials Plant). The quantity of each material was calculated according to reaction (1). To densify the hot-pressing product, 2 percent of Ni powder (made by the Beijing Iron and Steel Research Institute) was added. The purpose of using TiH_2 is that TiH_2 will decompose to reactive neo-titanium. Table 1 shows the properties of different starting powders. The raw materials were first mixed and then ground in an Al_2O_3 ball mill for 12 hours with alcohol as grinding medium. The ground mixture was dried and then hot-pressed in vacuum at 1,850°C and 25 MPa for 30 minutes.

Table 1. Properties of Various Powders

Powder	Chemical composition in mass percent	Particle size μm*
BN	BN (99.30), fB (0.13), fB_2O_3 (0.44), Na_2O (0.14), Fe_2O_3 (0.05), NiO (0.02)	Approx. 1
TiH_2	—	< 30
B_4C	—	5-8
Ni	—	< 0.1

*Obtained by SEM.

2.2 Property Measurements

2.2.1 Hardness: The specimens were strips made by electrospark cutting, followed by polishing. They were tested for Vickers hardness under a 20-Kg load. The result is the average of 10 readings.

2.2.2 Bending strength by a three-point test: The specimens were made by electrospark cutting. One side of each specimen was polished with a diamond grinder. The dimensions of a test specimen were: 2.7 mm x 4.7 mm x 35 mm. The span between the two supports was 20 mm. The loading speed was 0.5 mm/min. The result is the average of five tests.

2.2.3 Electrical resistance at room temperature: A four-point-probe method was used to measure electrical resistance at room temperature. The result is the average of five tests.

2.2.4 Phase analysis: The composite phases were analyzed by X-ray diffraction (XRD). Figure 1 shows the XRD spectrum. The boron content in the specimen was determined by chemical analysis, and its phase composition (weight percentage) was calculated.

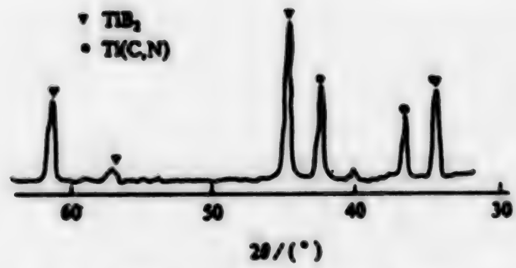

Figure 1. XRD Pattern of Ceramics Composite Produced by Reactive Hot Pressing

2.2.5 Microstructure analysis: A scanning electron microscope (SEM) with an electron acceleration voltage of 20 KV was used to study the microstructures of the polished surfaces and fracture surfaces.

Table 2 shows the test results.

Table 2. Properties of TiB_2-$TiC_{0.5}N_{0.5}$ Ceramic Composite

Relative density/%	Vickers hardness/ GPa	Bending strength/ MPa	Electrical resistance/ μΩ-cm	Mass composition of phase/%	
				TiB_2	$TiC_{0.5}N_{0.5}$
97.0	25	435 +/- 6.8	15.9	59.8	40.2

3. Analysis and Discussion

The XRD spectrum shows that there are only TiB_2 and Ti(C,N) phases in the ceramic composite. Chemical analysis also reveals that the composition of each phase is close to the composition derived from theoretical analysis. These facts indicate that the aforementioned chemical reactions are correct. We can assume that the adjustments of the values of α, β, and x in reactions (1) and (2) will change the mass ratio of TiB_2 and Ti(C,N) phases as well as the mass ratios of C and N in Ti(C,N). It is possible that the properties of TiB_2-Ti(C,N) ceramic composites can be adjusted within a wide range.

The binary phase diagrams of TiB_2-TiC and TiB_2-TiN show that at the experimental temperature the mutual solubility between TiB_2 and TiC or TiN is very limited and can be ignored. Further discussion will not consider the mutual solubility factors. Figure 2 [photographs not reproduced] shows the BSE morphology of the polished surface of the ceramic composite. In the photographs, TiB_2 appears to be dark gray; Ti(C,N), light gray; Ni, white; and gas holes, black. Figure 2 also shows the following features: very nonuniform distribution of TiB_2 and Ti(C,N) phases; gas holes; and a wide range of grain sizes. Some of the TiB_2 grains reach 10 μm, about the size of raw TiH_2 powder grains. Generally speaking, TiB_2 grains are much larger than Ti(C,N) grains. The additive, fusing-aid Ni, exists mainly in the interfaces among three grains.

In Figure 2b, the gas holes can be divided into two categories. One is called primary gas holes, which vary in sizes, some as large as 10 μm. Most of these gas holes are surrounded by grains. These holes are presumably generated by the arch-effect between particles during forming. Primary holes can be eliminated by adjusting powder properties and production conditions. Holes in the other category are called secondary gas holes; these are quite uniform in size, uniformly distributed, and exist in the triangular grain boundaries. The secondary gas holes are probably caused by two factors: First, inappropriate production technique that could not eliminate the residue gas holes during forming. Second—probably the main cause—these holes are produced by the differences of the solubilities of elements in liquid titanium during the course of reactive hot-pressing. The binary phase diagrams of Ti-B,[5] Ti-C, and T-N[6] show that at a hot-pressing temperature of 1,850°C, the maximum solubilities of B, C, and N in liquid titanium (Ti(1)) are 22, 9, and 2 atomic percent, respectively. When the compositions of B, C, and N exceed these solubility limits, Ti-B, TiC, and β-Ti will appear, respectively. However, when both B and C are in the solution, β-Ti may not exist in the Ti(1). Therefore, we can infer that TiN is formed along with the TiC formation according to the following reactions:

$$Ti(1) + C \rightarrow TiC(s) \qquad (3)$$

and $TiC + Ti(1) + C + N \rightarrow TiC_xN_{1-x}(s) \qquad (4)$

which means that the newly formed TiC acts as nuclei for the formation of TiC_xN_{1-x}. The formation of TiB_2 is due to the fact that the B quantity in liquid titanium exceeds the saturated concentration and produces the following reaction:

$$Ti(1) + 2B \rightarrow TiB_2(s) \qquad (5)$$

Due to the fact that the solubility of boron in Ti(1) is far greater than that of nitrogen, when both boron and nitrogen dissolve in Ti(1), the solution tends to reject nitrogen. Consequently, the rejected nitrogen is sealed in the specimen during hot-pressing and forms very minute holes. To eliminate these holes, the x value in TiC_xN_{1-x}, and the α and β values in reactions (1) and (2) should be adjusted so that the formation rates of TiB_2 and TiC_xN_{1-x} are compatible with the dissolving rates of B, C, and N in Ti(1). The aforementioned cause of nitrogen rejection is similar to the nitrogen rejection phenomenon caused by different solubilities of the elements in liquid Ni during the sintering of metallic ceramic TiN-Ni.[7]

Another remarkable phenomenon as shown in Figure 2a is the dispersion of segregated Ti(C,N) crystals in the TiB_2 grains. There is great variation in crystal sizes, about 10 nanometers. Similarly, the segregated nanoscale TiB_2 crystals also exist in the Ti(C,N) grains. The segregated TiB_2 crystals are even smaller than the segregated Ti(C,N) crystals. In another investigation, Williams et al.[8] discovered that the segregated TiC crystal flakes exist in TiB_2 and ZrB_2 single crystals, and the segregated TiB_2 crystals exist in TiC_x single crystals. The segregated crystals with sizes of a few nanometers were caused by the additives (such as B, etc.). They also thought that the segregated nanoscale crystals could modify the material properties, but they did not report further.

Figure 3 [photographs not reproduced] shows the SEM fractographs of TiB_2-$TiC_{0.5}N_{0.5}$ ceramic composite. It reveals that the crack propagates transgranularly when it encounters a large crystal grain. Figure 3d shows the morphology of a transgranular fracture, as well as the mode of crack propagation. When a crack extends to a large grain, it divides into a fork with one branch moving along the grain boundary while the other penetrates through the large grain. This observation shows that the TiB_2-$TiC_{0.5}N_{0.5}$ ceramic composite made by reactive hot-pressing method has higher grain boundary strength, which is possibly improved by the fusion-aid agent Ni. In other words, when the nanoscale TiB_2 and Ti(C,N) dispersion method is used to improve the properties of TiB_2-Ti(C,N) ceramic composite, measures should be taken to increase the grain boundary strength, so that the transgranular fracture will become the main failure mode.

4. Conclusions

(1) It is possible to make TiB_2-Ti(C,N) ceramic composite by the reactive hot-pressing process, which is simple and less expensive.

(2) When B, C, and N dissolve in Ti(1) and form a saturated solution, the formation of TiB_2-Ti(C,N) is postulated according to the following process:

$$Ti(1) + 2B \rightarrow TiB_2(s);$$

$$Ti(1) + C \rightarrow TiC(s);$$

$$\text{and } TiC(s) + Ti(1) + C + N \rightarrow Ti(C,N)(s).$$

(3) The nanoscale Ti(C,N) crystals disperse in the TiB_2 grains. At the same time, the nanoscale TiB_2 crystals also disperse in the Ti(C,N) grains. This phenomenon may affect the properties of the material. It requires further study.

(4) Cracks propagate transgranularly when they encounter large grains.

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Isolation of Epidemic Hemorrhagic Fever Virus From a Premature Brain Infected in Utero

40091017E Shanghai ZHONGHUA CHUANRANBING ZAZHI [CHINESE JOURNAL OF INFECTIOUS DISEASES] in Chinese Vol 11 No 2, May 93 pp 93-96

[English abstract of article by Shang Shouli [1424 1343 4409], Ma Lixian [7456 4539 2009], et al. of the Department of Infectious Diseases, Shandong Medical University, Jinan]

[Text] A strain of virus was isolated by cell culture and epidemic hemorrhagic fever (EHF) viral antigen was identified by immuno-histochemical staining from brain tissue of a 7-month dead fetus aborted from a pregnant woman, who was suffering from EHF at febrile phase. After a series of specific serologic tests and animal inoculation study, the virus was determined to be Hantaan strain of EHF virus, and the possibility of reovirus contamination was ruled out. This virus could be steadily passed on Vero E6 cell line, producing typical cytopathic effect and with strong antigenicity.

Studies on Combined Administration of Hepatitis B Vaccine With Measles Vaccine

40091017D Shanghai ZHONGHUA CHUANRANBING ZAZHI [CHINESE JOURNAL OF INFECTIOUS DISEASES] in Chinese Vol 11 No 2, May 93 pp 89-92

[English abstract of article by Li Xuexiang [2621 7185 5046], Kang Laiyi [1660 0171 0308], et al. of the Shanghai Institute of Biological Products, Shanghai]

[Text] To assess the immunogenicity of combined administration of hepatitis B (HB) vaccine with measles vaccine, a total of 64 infants were divided into A and B groups. Group B received only measles vaccine, while group A received HB vaccine at 0.1.8 months and 0.35 ml of measles vaccine was given at different spot simultaneously with the third HB vaccine. The seroconversion rates of hemagglutination inhibition in the groups A and B were 96.6 percent and 100 percent respectively one month after vaccination, the respective GMT being 1:38.9 and 1:42.4 ($t = 0.36$, $P > 0.05$), there was no significant difference between the two groups. Anti-HBs titres in group A were significantly higher after combined administration than before, from 229.4 mIU/ml increased to 918.1 mIU/ml. The simultaneous administration of hepatitis B vaccine and measles vaccine will not interfere with each other when given together at 8 months of age.

The Protective Effects of Twelve Traditional Chinese Medicines in Single Agents on Sucking Mice Infected With Epidemic Hemorrhagic Fever Virus

40091017C Shanghai ZHONGHUA CHUANRANBING ZAZHI [CHINESE JOURNAL OF INFECTIOUS DISEASES] in Chinese Vol 11 No 2, May 93 pp 81-84

[English abstract of article by Liu Zefu [0491 3419 1381], Li Zuohong [2621 4373 1347], et al. of the Department of Infectious Diseases, Tangdu Hospital, Fourth Military Medical University, Xian]

[Text] The protective effects of twelve traditional Chinese medicines were tested separately on the suckling mice infected with epidemic hemorrhagic fever (EHF) virus (strain 76/118). The results showed that Rheum officinale Baill, polygonum cuspidatum Sieb et Zuco, Scutellaria capillaris Thunb and Loranthus parastiticus (L) Merr. had evident protective effects on the infected suckling mice, but Artemisia capillaris Thunb, Sonchus brachyotus D. C, Taxaxacum mongolium Hand-Mazz, Lonicera confusa D. C., Belamcanda chinensis D. C, Bupleurum chinense D. C, Lunathyrium acristichoides (Sw) Ching and Eupatorium fortunei Turcz did not show evident protective effects. The potency of the protective effects is related to infectious doses, the dose of the traditional Chinese medicine and its time of administration. The antigen titer of the brain suspension of the suckling mice was measured by the double indirect sandwich McAb-ELISA technique. The optimal dose is between 2.4 and 3.6 g/kg and the highest protective rate is obtained with medication given between 24 and 72 hours after viral infection. The protective effects were shown as delay in the time of onset of the disease and death of the infected suckling mice or prolongation of the course of the disease, sometimes the disease did not even occur; and the antigen titer in the brain of the suckling mice was reduced remarkably. If the traditional Chinese medicines are used in combination in an increased period of time, the protective rate might be enhanced.

Antigen-Enzyme Labeled Immunoelectrophoresis and Its Application for Quantitation of Components in Snake Venoms

40091017B Nanning SHEZHI [JOURNAL OF SNAKE] in Chinese Vol 5 No 2, Jun 93 pp 10-14

[English abstract of article by Liao Gongshang [1675 0364 1472], Lin Baixi [2651 2672 3305], and Huang Xiangping [7806 3276 5493] of the Snake Venom Research Institute, Guangxi Medical University]

[Text] A novel immunoassay named Antigen-Enzyme Labelled Immuno-electrophoresis (AELIE) with characteristics of high specificity and sensitivity was developed. A homologous antigen was labelled with horseradish peroxidase, trace amount of this labelled antigen was mixed with sample and electrophoresis was performed on an immunoplate containing ployspecific antiserum. Rocket-shape immunoprecipitates containing ployspecific antiserum were visualized by incubation with enzyme substrate. Positive correlation ($r = +0.98$) was obtained between rocket heights and concentrations of antigen. In this study the method was applied for quantitation of cardiotoxin and L-amino acid oxidase in snake venoms, the sensitivity was 30 fold increase as compared with protein stain technique and 20 fold increase as compared with enzyme assay while monitoring chromatography. By distinguishing specific

antigens in snake venoms this method may provide authentic evidence for diagnosis of snakebite and replace bioassay of various components in snake venoms.

Key words: Immunoelectrophoresis, Snake venom, Cardiotoxin, L-amino acid oxidase

Sodium Channel Blocking Effect of Scorpion Venom on Cultured Mouse Myocardiocytes

40091017A Shanghai ZHONGGUO YAOLI XUEBAO [ACTA PHARMACOLOGICA SINICA] in Chinese Vol 14 No 4, Jul 93 pp 361-364

[English abstract of article by Qi Hui [7871 2547], Zhong Guogan [6988 0948 6373], et al. of the Department of Physiology, Norman Bethune University of Medical Sciences, Changchun]

[Text] Myocardiocytes of mice were cultured. Action potentials were recorded with microelectrodes inside the cells. Scorpion venom from *Buthus martensii* Karsch 3.75 or 7.5 $\mu g\text{-}ml^{-1}$ decreased the duration of action potential and all of the depolarization concerned parameters of myocardiocytes. The V_{max}, TP [threshold potential], APA [action potential amplitude] behaved apparently in a dosage-dependent way. Restoration happened after washing out. Tetrodotoxin 2.5 $\mu g\text{-}ml^{-1}$ acted in a similar way. Nimodipine 3.0 $\mu g\text{-}ml^{-1}$ led to a decrease in action potential duration. $BaCl_2$ 0.1 $mmol\text{-}L^{-1}$ elongated the action potential duration, while decreased the parameters concerned with depolarization. These results indicate that the scorpion venom has Na^+ channel blocking action.

Chinapac Packet-Switching PDN Launched

93P60334B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 31, 11 Aug 93 p 1

[Article by Xing Hua [5281 5478]: "Computer Network Linkup Implements Database Resource Sharing: China's Newly Built Packet-Switching Public Data Network Put Into Operation"]

[Summary] China's newly built national packet-switching public data network (Chinapac PDN), after 1-month-plus of trial operation, was formally put into operation on 20 July, marking the nation's entry into a new era of computer communications. The old packet-switching PDN, whose equipment was imported from France's SESA in 1988 and put into operation in November 1989, had only 580 ports, and capacity had become saturated; also, the bit rate and number of synchronous ports were quite low. MPT therefore decided to build a new national packet-switching PDN with DPN-100 equipment (a third-generation product) imported from Canada's Northern Telecom. This new national backbone network consists of 32 nodes and 5,540 ports. In the initial period of this still-uncompleted network, eight cities—Beijing, Shanghai, Shenyang, Wuhan, Chengdu, Xian, Nanjing, and Guangzhou—form a tandem center, with Beijing being the international gateway.

More on Chinapac Network

40100107A Beijing CHINA DAILY in English 2 Sep 93 p 3

[Text] China launched a new network to improve communications between computers and data terminals (Chinapac) yesterday in order to meet the needs of the country's information industry.

Officials from the Ministry of Posts and Telecommunications said at a press conference that Chinapac is an internationally-advanced data communications network combining computer technology and communications.

The new system is needed because a data-switching network built in 1989 can no longer meet the demand because of its limited capacity.

In addition to various basic services, Chinapac also offers electronic mail box, videotex, electronic data interchange and data retrieval services.

Chinapac, which covers capital cities of all mainland provinces and autonomous regions and Beijing, Shanghai, Tianjin and Chongqing in Sichuan Province, can also be connected with the public telephone network to cover all of the country's counties and cities.

In its early stages Chinapac will have 5,500 terminal ports, but it also will have international gateways in Beijing and Guangzhou, which can be connected with networks in the United States, Japan, France, Germany, Italy, the Republic of Korea, Hong Kong and other countries and regions, enabling subscribers to have data links with nearly 40 countries and regions.

The ministry will use optical fibre, data microwave, satellite and many other advanced transmission systems to make sure the network operates as a high-speed, high-quality and high-capacity system.

All of China's provinces and autonomous regions have been constructing their own local data-switching networks that are due to start operation at the end of this year or early next year.

At that point the total number of terminal ports in Chinapac will reach about 20,000.

Beijing Simulation Center Passes State Acceptance Check

93P60334A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 31, 11 Aug 93 p 1

[Article by Liu Jiuru [0491 0046 1172]: "Beijing Simulation Center Passes State Acceptance Check"]

[Summary] The independently designed and developed Beijing Simulation Center (BSC)—one of the world's largest and most advanced such facilities—passed the formal state acceptance check conducted by the China Space Industry Corporation's Second Academy on 30 July. According to the state acceptance committee's testing and appraisal, this 11-laboratory facility's overall performance indicators are at the international state-of-the-art, with some totally new aspects. Jiang Zemin, Li Peng, Zou Jiahua, Wen Jiabao, Song Jian and other party and government leaders wrote inscriptions or sent their congratulations on this occasion. Among the 11 labs in BSC, the Radio-Frequency-Homing [Missile] Guidance Simulation Laboratory is microwave and millimeter-wave compatible; this dual function for one lab is a major breakthrough in simulation technology. BSC's principal objective is digital simulation and hardware-in-the-loop simulation of aircraft and spacecraft, including launch vehicles. The center is open to foreign researchers and is actively seeking simulation business in communications, energy resources, chemical engineering, and other major civilian systems engineering disciplines.

Wanbang Introduces Intelligent Computerized Telephone Operator

93P60334C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 31, 11 Aug 93 p 2

[Article by Wei Ru [0251 1172]: "Wanbang Introduces Intelligent Computer Telephone Operator"]

[Summary] Wanbang [8001 6721] Communications Technology Company has recently developed an intelligent "computer telephone operator." The firm, which first invested talent and financial assets in this project in 1990, received a state patent in 1992 for this invention, which passed the formal tests conducted by MPT's Communications Measurement Center in October 1992. After receiving the patent, Wanbang began manufacturing and marketing of the product, while simultaneously improving reliability and performance by incorporating such advanced concepts as fuzzy logic theory and optimized algorithms. Also, for the convenience of customers, Wanbang has designed and installed general-purpose interface circuits and flexible switches suitable both for crossbar and for SPC user exchanges [i.e., PABXs]. Wanbang's computer telephone operator is now in trial operation at a number of domestic units, with initial feedback being quite favorable.

JCS-FMS-2 Flexible Manufacturing System for Speed Reduction Machine Frames

93P60331A Beijing JICHUANG [MACHINE TOOLS] in Chinese No 7, Jul 93 pp 33-36

[Article by Yu Shengmei [0205 5110 2734] of the Beijing Machine Tool Institute: "JCS-FMS-2 Flexible Manufacturing System for Speed Reduction Machine Frames"; MS received 14 Jan 93]

[Abstract] The JCS-FMS-2 flexible manufacturing system (FMS) for machining speed reduction machine frame parts has been developed as an 863 Plan CIMS [computer integrated manufacturing systems] project by the Beijing Machine Tool Institute [JCS, from the Pinyin Jichuang Suo] at the request of the Tianjin Speed Reduction Machine General Plant. This system, which passed the acceptance check conducted in November 1992 by MMEI's Machine Tool Instruments Department and which is now in production at the Tianjin plant, is intended for annual machining of 10,000-15,000 HT200 cast iron parts in eight different varieties. JCS-FMS-2 consists of a cell controller (AMCC-1) based on a TJ [Taiji] 2220 host computer (DEC MicroVAX II class, with 9 MB internal memory, 182 MB hard disk memory); a machining workstation, including a TJ-IC-011 industrial microcomputer (PC-XT class), high-resolution color monitor, intelligent communications board, DOS system disk (version 3.0 or higher), UCDOS Chinese version system C5.0 compiler, and MASM macroassembler; a materials flow management workstation, including a TJ-IC-011 industrial control computer with PCL-7251/D board, MS-DOS 3.20 operating system, and C5.OTURBOC2.0 software development support tool; a materials storage and transport system, consisting of 20 workpiece pallet stations, three dual-position APC [automatic parts change] units, a 500-kg automatic guided vehicle (AGV), and one AGV battery-charging apparatus; three machining cells, specifically one XH714 vertical machining center (MC) with dual-position APC and two TH6350 horizontal MCs with dual-position APC; a jig system permitting machining of eight different frames with part dimensions (LWH) from 230 x 155 x 220 to 470 x 380 x 400 mm; parts machining programming software; and an on-cell monitoring system. The system machining times for speed reduction machine bottom surface, 0° side surface, 90° and 270° side surfaces, 180° side surface, and top surface are 10, 30, 6, 14, and 9 minutes, respectively.

A schematic drawing of the entire JCS-FMS-2 system is shown below. Two other figures, not reproduced, show a typical speed reduction machine front view and cross section, and a workpiece flowchart, respectively.

No references.

Figure 1. Schematic of JCS-FMS-2

Parameterization Method for Nuclear Explosion Signal, Its Application

93P60320B Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 15 No 4, Jul 93 pp 382-387

[Article by Feng Diqing [7458 0266 3237], Miao Chang [4924 1603], and Zhao Ming [6932 2494] of the College of Chemical Defense (Chemical Defense Command Engineering Institute, Teaching and Research Section 7), Beijing 102205, and Wang Feng [3769 6912] of the Institute of Chemical Defense (Chemical Defense Academy, Institute 2), Beijing 102205: "Parameterization Means of Nuclear Explosion Signal and Its Application"; MS received 21 Mar 92, revised 6 Jul 92]

[Abstract] An improved method for parameterization of an instantaneous signal of a nuclear explosion is presented, and its applications in the field of nuclear explosion detection are presented. Discussion centers on improvements to the ARMA [autoregressive moving average] and Kumaresan-Prony models [refs. 3-6] and algorithms for extracting signal parameters. Finally, two examples illustrating application of the models and algorithms to nuclear explosion detection and computer simulations thereof are given. The first example uses the second flash (light pulse) waveform from the nuclear blast to distinguish between air and ground explosions. Effectiveness tests indicate that out of 25 air explosions, 22 were correctly recognized and 3 were incorrectly recognized; and out of 25 ground explosions, 23 were correctly recognized, with 2 false readings. This constitutes a 90 percent correct recognition rate for all 50 samples. The second example uses the nuclear electromagnetic pulse (EMP) to recognize (i.e., distinguish between) a nuclear blast vs. lightning, and an atomic bomb vs. a hydrogen bomb. Effectiveness tests with 18 nuclear blast samples and 137 lightning samples produced an agreement rate of 88.9 percent for the former and 100 percent for the latter, constituting an overall accuracy rate of 98.7 percent. Effectiveness tests with 13 atomic bomb samples and five hydrogen bomb samples produced an agreement rate of 92.3 percent for the former and 100 percent for the latter, constituting an overall accuracy rate of 94.2 percent.

No figures or tables.

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Efficient Multirate Preprocessing Technique for Microwave Imaging

93P60320C Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 15 No 4, Jul 93 pp 410-415

[Article by Li Wende [2621 2429 1795], Wang Zhenrong [3769 2182 2837], and Xue Minghua [5641 2494 5478] of Teaching and Research Section 205, Beijing University of Aeronautics and Astronautics, Beijing 100083: "Efficient Multirate Preprocessing Technique for Microwave Imaging"; MS received 4 May 92, revised 16 Aug 92]

[Abstract] High-resolution microwave imaging based on SAR/ISAR [synthetic aperture radar/inverse synthetic aperture radar] principles has been shown to be quite useful in the fields of geology, remote sensing, military reconnaissance, and electromagnetic scattering measurement. In this paper, an effective multirate preprocessing technique for microwave imaging is presented. This technique has the advantages of greatly compressing the original collected spectral data (1024 x 64 data samples before preprocessing and 45 x 64 after preprocessing) and reducing computational complexity of some imaging algorithms. The preprocessed spectral data is suitable for off-line superresolution imaging processing.

The experimental imaging system consists of a model aircraft on a turntable, a transmitting antenna, a receiving antenna, an RF power amplifier, a microwave linear sweep frequency source, a mixer, an amplifier, an A/D converter, a computer, and a turntable controller. The system was tested in a microwave darkroom equipped with a compact test range; experimental parameters are as follows: linear FM signal frequency of 8-12 GHz, pulse width of 16 ms, turntable-to-antenna distance of 15.5 m, 94-tap linear-phase FIR low-pass filter, pass-band width of 0.8 m, transition bandwidth of 1.2 m, and filter parameters as given in ref. 6. The testing demonstrates that this low-sampling-rate preprocessing technique raises imaging processing speed and lowers required memory space while preserving the integrity of the original collected spectral data. This is illustrated in Figures 4, 8, and 9 (reproduced below), which depict the

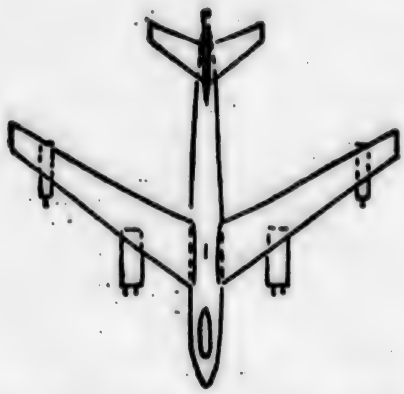

Figure 4. Schematic of Bomber Model Used in Testing

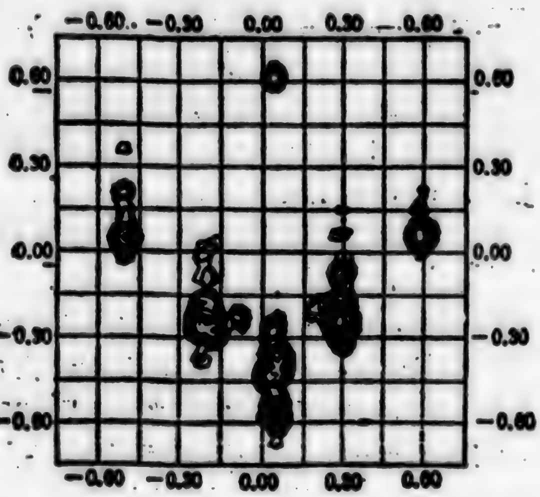

Figure 8. Imaging Results From Original Spectral Data

bomber model used in the testing, the direct imaging results using the original spectral data, and the imaging results after using the variable-sampling-rate data preprocessing technique.

Six other figures (not reproduced) illustrate various system schematics and graphs of measured data. There are no tables.

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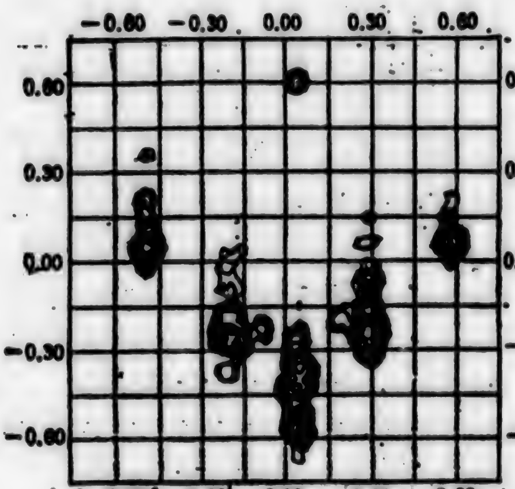

Figure 9. Imaging Results Using Variable-Sampling-Rate Data Preprocessing Technique

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Real-Time Object Recognition System Based on Feature Matching

93P60320A Beijing ZIDONGHUA XUEBAO [ACTA AUTOMATICA SINICA] in Chinese Vol 19 No 4, Jul 93 pp 428-432

[Article by Xu Zhengwei [1776 2973 0251], Zheng Lanfang [6774 5695 5364], et al. of the Dept. of Information Engineering, Xidian University, Xian: "Real-Time Object Recognition System Based on Feature Matching"; MS received 4 Dec 91]

[Abstract] A real-time object or target recognition system based on feature matching is described. System hardware consists of an IBM PC/AT, bus interface and control circuits, a camera, a monitor, a video interface, an image frame buffer, and a reconfigurable parallel processor. The parallel processor, which can be configured into any one of three schemes (SIMD, MISD, or MIMD), consists of two TMS320C25 DSP chips and

four 64 KB image memory modules (total of 256 KB of image memory). The system can recognize more than 29 object models of different shapes or more than 11 airplane models with similar shapes. Recognition results are translation-invariant, rotation-invariant, and scale-invariant. Experiments show that the correct recognition rate exceeds 98 percent and that recognition time is under 34 ms, meeting the military and/or industrial-automation requirement for real-time recognition of moving objects.

Four figures, no tables.

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2D Surface Array Infrared Detector Developed by CAS Institute

93P60333A Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 28 Jul 93 p 2

[Article by Liu Li [0491 0500]: "CAS Institute of Semiconductors Develops Two-Dimensional Surface Array Infrared Detector"]

[Summary] In a 2-year project, scientists at the CAS Institute of Semiconductors have developed a two-dimensional (10 x 16-element) surface HgCdTe (mercury-cadmium-telluride) infrared detector array with a peak wavelength of 9.4 microns. This high-resolution, high-sensitivity device—used in the Gulf War and embargoed by Western nations—was developed via the institute's own ultra-thin-layer epitaxial material technique and incorporates surface grating coupling and vertical incidence operation. Device performance parameters—black-body detectivity, peak responsivity, and response bandwidth—are all state-of-the-art. This IR detector array is expected to have applications in the defense and space sectors.

Domestically Made a-Si/Si-Heterojunction Microwave Power Transistor Cutoff Frequency Exceeds 10 GHz

93P60333B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 2 Aug 93 p 1

[Article by An Nan [1489 0589]: "Beijing University New Devices Laboratory Climbs Another Peak"]

[Summary] According to a report from the NDSTIC Second Testing and Research Center, scientists at the Beijing University New Devices Laboratory (BUNDL) have realized another pioneering achievement. The BUNDL researchers, led by Prof. Zhu Enjun [2612 1869 0971] and aided by a MBE technique perfected by colleagues at Fudan University's Surface [Physics] Laboratory, have developed an amorphous-silicon/silicon-heterojunction microwave power transistor with a cutoff frequency of 12,000-13,500 MHz [12-13.5 GHz]. Such high-frequency performance has traditionally been available only with GaAlAs/GaAs and Si/GeSi heterojunction structures. This pioneering achievement forms a solid foundation for the domestic development of 3 GHz-and-above microwave power transistors fabricated from silicon and for domestic development of silicon-based VHSICs.

Growth, Characteristics of Carbon-Doped $In_xGa_{1-x}As$ by MOMBE

40100103A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 7, Jul 93 pp 402-409

[English abstract of article by Qi Ming and Luo Jinsheng of the Department of Electronic Engineering, Xi'an Jiaotong University, Xi'an 710049; J. Shirakashi, T. Yamada, S. Nozaki, and K. Takahashi of the Department of Physical Electronics, Tokyo Institute of Technology; and E. Tokumitsu and M. Konagai of the Department of Electrical and Electronic Engineering, Tokyo Institute of Technology; MS received 11 Dec 91, revised 11 May 92]

[Text] The properties of carbon-doped $In_xGa_{1-x}As$ (x = 0-0.98) grown by MOMBE [metal-organic molecular beam epitaxy] using TMG, solid In and solid As have been studied systematically. It is shown that the growth rate, indium mole fraction x and carrier concentration of the samples are strongly affected by the growth temperature and indium pressure-equivalent beam flux. The hole concentration decreases with increasing indium mole fraction in the range of x = 0-0.8, and the conduction type becomes n-type when x is higher than 0.8. The mechanism of carbon incorporation in $In_xGa_{1-x}As$ grown by MOMBE and its influence on carrier concentration and conduction type are discussed according to the experimental results. The quality of the epitaxial layers has been analysed by X-ray diffraction (XRD) and photoluminescence (PL).

Quantitative Auger Electron Spectroscopy Analysis of $In_xGa_{1-x}As$ Grown by Molecular Beam Epitaxy

40100103B Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 7, Jul 93 pp 410-415

[English abstract of article by Chen Weide and Cui Yude of the Institute of Semiconductors, CAS, Beijing, 100083 and National Laboratory for Surface Physics, CAS, Beijing, 100080, and Chen Zonggui of the Institute of Semiconductors, CAS, Beijing, 100083 and National Laboratory for Superlattices and Microstructures, Beijing, 100083; MS received 11 Dec 91, revised 3 Mar 92]

[Text] Quantitative Auger analysis $In_xGa_{1-x}As$ grown by molecular beam epitaxy (MBE) has been performed with an internal standard element method. It is shown that matrix correction for $K^{InGa}{}_M$ is about 1.08 and the composition dependence of $K^{InGa}{}_M$ is weak for the ternary compounds. No preferential sputtering of As was found and sputter correction factor $K^{InGa}{}_s$ is equal to 0.75. Finally, the quantitative results obtained using this method and those by X-ray double-crystal diffraction analysis are compared.

Low Threshold Buried-Heterostructure AlGaAs Lasers

40100103C Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 7, Jul 93 pp 445-449

[English abstract of article by Yang Guowen, Xiao Jianwei, et al. of the Institute of Semiconductors, CAS,

National Integrated Optoelectronics Lab., Beijing 100083; MS received 9 Dec 91, revised 25 Feb 92]

[Text] A study of low threshold GaAs/GaAlAs BH lasers is reported. Using an LPE system, LPE growth of a DH [double heterostructure] wafer and LPE regrowth of a BH wafer were performed. By optimization of the structure design and improvement in process technique, the expected performance of low threshold current was achieved. The broad area threshold current density of the DH wafer is generally in the range of 800-1,000 A/cm^2, and the lowest is 675 A/cm^2. After the LPE regrowth, the threshold current is lower than 10 mA, and the lowest is 4 mA. To our knowledge, this is one of the lowest thresholds for a DH laser diode yet reported.

Buried Ridge-Multi-Quantum-Wire Arrays on Nonplanar Substrates Grown by MBE

40100103D Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 7, Jul 93 pp 456-459

[English abstract of article by Qian Yi, Xu Junying, et al. of NIOEL, Institute of Semiconductors, CAS, Beijing 100083, Zhou Xiaochuan, Jiang Jian, and Zhong Zhantian of the National Laboratory for Surface Physics, CAS, Beijing 100080; MS received 9 Dec 92, revised 3 Feb 93]

[Text] Buried GaAs/AlGaAs ridge-multi-quantum-wire arrays have been grown for the first time by in situ one-step MBE technique on GaAs substrates processed by conventional photolithology and wet chemical etching. Electron microscopy, conventional photoluminescence and confocal photoluminescence were performed and give evidence of 2-dimensional quantum-confinement. Theoretical analyses and calculations also demonstrate that the effective dimension of the lateral carrier confinement reaches quantum size.

Heavily Carbon Doped p-Type GaAs/$In_xGa_{1-x}As$ Strained-Layer Superlattices Grown by MOMBE

40100105A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 8, Aug 93 pp 461-467

[English abstract of article by Qi Ming and Luo Jinsheng of the Department of Electronic Engineering, Xi'an Jiaotong University, Xi'an 710049; J. Shirakashi, T. Yamada, S. Nozaki, and K. Takahashi of the Department of Physical Electronics, Tokyo Institute of Technology; and H. Kashima, E. Tokumitsu, and M. Konagai of the Department of Electrical and Electronic Engineering, Tokyo Institute of Technology; MS received 7 Jan 92, revised 11 May 92]

[Text] Heavily carbon doped p-type GaAs/$In_xGa_{1-x}As$ (x = 0.3) strained-layer superlattices (SLSs) with effective hole concentration as high as 1 x $10^{20}/cm^3$ have been grown successfully for the first time by MOMBE using TMG [trimethyl gallium], solid indium and solid arsenic. The samples are characterized by XRD, Raman, PL and Hall measurements. The influences of the structural parameters on the relaxation of misfit strain and the properties of the SLSs are discussed. It is shown that the SLSs grown by MOMBE are of very high hole concentration and lower effective bandgap, making them useful as a base material for GaAs-based HBTs.

Wannier-Stark Effects in InGaAs/GaAs Short-Period Strained Superlattices

40100105B Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 8, Aug 93 pp 517-521

[English abstract of article by Liu Wei of the National Laboratory for Superlattices and Microstructures, Institute of Semiconductors, CAS, Beijing 100083 and the Department of Physics, Beijing Normal University, Beijing, 1000875; Zhang Yaohui and Jiang Desheng of the National Laboratory for Superlattices and Microstructures, Institute of Semiconductors, CAS, Beijing 100083; Wang Ruozhen of the Department of Physics, Beijing Normal University, Beijing 1000875; and Zhou Junming and Mei Xiaobing of the Institute of Physics, CAS, Beijing 100080; MS received 26 Nov 92, revised 3 Mar 93]

[Text] Photocurrent spectra in the temperature range of 10-300K have been made to investigate Wannier-Stark localization effects in $In_{0.2}Ga_{0.8}As$/GaAs short-period strained superlattices. Both at room and low temperature, we have observed the field-induced "blue shift" of the absorption edge, and discuss the variations of the energies and strengths of the Stark-ladder excitonic transitions with electric field. The experimental results show that electro-optical modulation devices performing at wavelength of about 9800 Angstroms [0.98 μm] can be made by using Wannier-Stark localization effect in $In_{0.2}Ga_{0.8}As$/GaAs superlattices.

High-Tc Superconducting Infrared Bolometer

40100106A Hefei DIWEN YU CHAODAO [CRYOGENICS AND SUPERCONDUCTIVITY] in Chinese Vol 21 No 1, Feb 93 pp 33-36

[English abstract of article by Wan Fabao, Xu Ming, et al. of the Department of Physics, Northwest University, Xian; Li Hongcheng, Wang Ruilan, and Li Jingwei of the Institute of Physics, CAS, Beijing; and Wang Shulin of Xian Mineralogy College; MS received 28 Aug 92]

[Text] Two kinds of bolometers which are different in structure have been fabricated out of GdBaCuO superconducting thin films by photolithography techniques. The thickness of the substrates has been reduced to about 50 μm. Near the transition midpoint, the properties of the devices have been measured. The optimum results are as follows: NEP [noise equivalent power] (500, 10, 1) = 3.7×10^{-11} $WHz^{-1/2}$, D* [detectivity] (500, 10, 1) = 1.9×10^{9} $cmHz^{1/2}$ W^{-1}, R_v [responsivity] = 234 V/W.

DC-SQUID on a Bicrystal Substrate

40100106B Hefei DIWEN YU CHAODAO [CRYOGENICS AND SUPERCONDUCTIVITY] in Chinese Vol 21 No 1, Feb 93 pp 37-40

[English abstract of article by Zeng Xianghui, Wang Shiguang, et al. of the Department of Physics, Beijing University; MS received 16 Oct 92]

[Text] A bicrystal substrate has been fabricated with ZrO_2 single crystal. The YBCO thin film was deposited by laser ablation, and the SQUID was patterned with photolithography and Ar ion beam etching. The YBCO thin film has Tco ≃ 90K, and the SQUID has Tco ≃ 86K. Superconducting interference effect was observed at a temperature as high as 85K.

Xian-Lanzhou-Urumqi Fiber Optic Cable Under Construction

93P60332A Lanzhou GANSU RIBAO in Chinese 2 Aug 93 p 1

[Article by Lin Zhigang [2651 1807 0474]: "Xian-Lanzhou-Urumqi Fiber Optic Cable Communications Trunkline Construction Under Way"]

[Summary] Construction on the 3,200-km-long Xian-Lanzhou-Urumqi fiber optic cable trunkline is now under way. This follows upon the recent initial design certification conducted by the State Planning Commission and MPT. The Lanzhou-Urumqi segment construction is being funded by an Australian government loan. Gross project investment is 739 million yuan, and scheduled operational date for the entire trunkline is September 1994.

'Flash-II': China's Accelerator Research Reaches World Level

93FE0875B Hangzhou ZHEJIANG RIBAO in Chinese 3 Jul 93 p 3

[Article by unknown correspondent of Xinhua News Agency: "'Flash-II': China's Accelerator Research Reaches World Level"]

[Text] The "Flash-II," a low-energy, high-intensity pulse current relativistic electron beam accelerator, passed governmental appraisal. The completion of this key state high-tech project puts China among the leaders in the field, after the United States and Russia.

As a simulated source in an intense pulse beam experiment, this low energy intense current pulse relativistic electron beam accelerator can simulate a variety of important physical phenomena such as pulse electron beam effect, X-ray effect and electromagnetic effect. It plays a unique role in areas such as aeronautics, astronautics, energy, laser, materials technology and high power microwave.

The appraisal showed that the "Flash-II" electron beam accelerator, which was successfully developed by several organizations including the Northwest Institute of Nuclear Technology, has unique features such as high beam current, low impedance and advanced structure. The maximum current is 1 million amperes and the maximum power is 1 trillion watts. The pulse width is less than 0.1 microsecond. Moreover, a number of major technical breakthroughs in high power switching, high voltage insulation, pre-pulse voltage suppression and electron beam spot size control were realized. It has a major impact on further advances in high-tech research, industrial application and defense.

The "Flash-II" electron beam accelerator is a key state technical project that began 10 years ago. Since its placement in test run in 1990, it has been very effective in basic and applied research and has demonstrated a bright future.

Ultra Sensitive Cyclotron Spectrometer Debuts in Shanghai

93FE0875A Shanghai JIEFANG RIBAO in Chinese 14 Jun 93 p 1

[Article by correspondents Tang Qinmei [0781 4440 2734] and Zheng Xian [6774 2009]: "Ultra Sensitive Cyclotron Spectrometer Debuts in Shanghai"]

[Text] Chinese scientists are making headlines again. Researchers at the Shanghai Institute of Nuclear Research of the Chinese Academy of Sciences, headed by Chen Maobo [7115 5399 2672], successfully developed the world's first ultra sensitive small cyclotron spectrometer by adopting novel physical designs and creative technical approaches. It passed the appraisal held by the National Natural Science Foundation yesterday. Experts unanimously agreed that the successful development of this device signifies that China is a leader in this research area.

Based on an informed source, a well-known laboratory began developing such a small ultra sensitive cyclotron since the early 1980's. It devoted over a decade and designed several schemes. However, it still has not succeeded. The researchers at the Institute of Nuclear Research solved the problem in a mere 50 months.

Accelerator mass spectroscopy (AMS) is a new ion beam separation analytical technique. Because it can precisely measure C-14, it becomes an important tool in age determination in astronomy, geography, archaeology and ecology. Nevertheless, AMS is usually done on large serial accelerators. Because it is very costly to build and maintain serial accelerator mass spectrometers, its widespread use becomes prohibitive. Hence, many laboratories and scientists have an urgent need for an economic small ultra sensitive accelerator mass spectrometer for age determination.

The group headed by Chen Maobo began a feasibility study on a small ultra sensitive cyclotron spectrometer at the Institute of Nuclear Research of the Chinese Academy of Sciences in 1985. They presented the novel concept of using a higher order frequency multiple and a triangular voltage wave form to improve the resolution and receptivity of the ion beam and the creative technical approach to implement the idea. The research plan was supported by the director of the institute, Professor Yang Fujia [2799 4395 1367], and the leadership at the National Natural Science Foundation. In 1988, the project was officially listed as a major project of the foundation.

Yesterday, this smallest cyclotron spectrometer made its debut. The main unit is approximately 1 m in diameter and 2 m high. It is one fifty-sixth the size of a conventional serial accelerator mass spectrometer. According to the experts, this ultra sensitive cyclotron spectrometer can "capture" a C-14 ion out of 10^{15} carbon ions. Furthermore, its cost is low and does not require any radiation protection facility. It can be installed in any trace level analysis laboratories.

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